



Europäisches
Patentamt
European
Patent Office
Office européen
des brevets



(11)

EP 3 299 439 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

19.12.2018 Bulletin 2018/51

(21) Application number: 17190953.4

(22) Date of filing: 13.09.2017

(51) Int Cl.:

C09K 19/18 (2006.01)

C09K 19/20 (2006.01)

C09K 19/32 (2006.01)

C09K 19/34 (2006.01)

C09K 19/30 (2006.01)

C09K 19/04 (2006.01)

C09K 19/06 (2006.01)

(54) LIQUID CRYSTAL COMPOUND, LIQUID CRYSTAL COMPOSITION AND LIQUID CRYSTAL DISPLAY DEVICE

FLÜSSIGKRISTALLVERBINDUNG, FLÜSSIGKRISTALLZUSAMMENSETZUNG UND
FLÜSSIGKRISTALLANZEIGEVORRICHTUNG

COMPOSÉ LIQUIDE CRISTALLIN, COMPOSITION À BASE DE CRISTAUX LIQUIDES ET
DISPOSITIF D'AFFICHAGE À BASE DE CRISTAUX LIQUIDES

(84) Designated Contracting States:

AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR

(30) Priority: 27.09.2016 JP 2016188634

(43) Date of publication of application:

28.03.2018 Bulletin 2018/13

(73) Proprietors:

- **JNC Corporation**
Chiyoda-ku
Tokyo 100-8105 (JP)
- **JNC Petrochemical Corporation**
Tokyo 100-0004 (JP)

(72) Inventors:

- **SASADA, Yasuyuki**
Chiyoda-ku, Tokyo 100-8105 (JP)
- **SAWADA, Michiko**
Ichihara-shi, Chiba 290-8551 (JP)

(74) Representative: **Thurston, Joanna**

Withers & Rogers LLP
4 More London Riverside
London SE1 2AU (GB)

(56) References cited:

WO-A1-2012/126565 WO-A1-2012/146340
JP-A- 2006 160 727

EP 3 299 439 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

Technical Field

5 [0001] The invention relates to a liquid crystal compound, a liquid crystal composition and a liquid crystal display device. More specifically, the invention relates to a liquid crystal compound having a triple bond, a liquid crystal composition having a nematic phase and containing the compound, and a liquid crystal display device including the composition.

Background Art

[0002] A liquid crystal display device has been widely utilized in a display of a personal computer, a television and so forth. The device utilizes physical properties such as optical anisotropy and dielectric anisotropy of a liquid crystal compound. As an operating mode of the liquid crystal display device, such a mode exists as a phase change (PC) mode, a twisted nematic (TN) mode, a super twisted nematic (STN) mode, a bistable twisted nematic (BTN) mode, an electrically controlled birefringence (ECB) mode, an optically compensated bend (OCB) mode, an in-plane switching (IPS) mode, a vertical alignment (VA) mode, a fringe field switching (FFS) mode and a polymer sustained alignment (PSA) mode. In the device having the PSA mode, a liquid crystal composition containing a polymer is used. In the composition, alignment of liquid crystal molecules can be controlled by the polymer.

[0003] In such a liquid crystal display device, a liquid crystal composition having suitable physical properties is used. In order to further improve characteristics of the device, the liquid crystal compound contained in the composition preferably has physical properties described in (1) to (8) below: (1) high stability to heat or light, (2) a high clearing point, (3) low minimum temperature of a liquid crystal phase, (4) small viscosity (η), (5) suitable optical anisotropy (Δn), (6) large dielectric anisotropy ($\Delta \epsilon$), (7) a suitable elastic constant (K) and (8) good compatibility with other liquid crystal compounds.

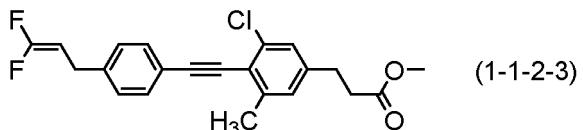
[0004] An effect of the physical properties of the liquid crystal compound on the characteristics of the device is as described below. A compound having the high stability to heat or light as described in (1) increases a voltage holding ratio of the device. Thus, a service life of the device becomes longer. A compound having the high clearing point as described in (2) extends a temperature range in which the device can be used. A compound having the low minimum temperature of the liquid crystal phase such as a nematic phase and a smectic phase as described in (3), in particular, a compound having the low minimum temperature of the nematic phase, extends the temperature range in which the device can be used. A compound having the small viscosity as described in (4) shortens a response time of the device.

device can be used. A compound having the small viscosity as described in (4) shortens a response time of the device. [0005] According to a design of the device, a compound having the suitable optical anisotropy, more specifically, a compound having large optical anisotropy or small optical anisotropy as described in (5) is required. When the response time is shortened by decreasing a cell gap of the device, the compound having large optical anisotropy is suitable. A compound having large dielectric anisotropy as described in (6) decreases threshold voltage of the device. Thus, electric power consumption of the device is reduced. On the other hand, a compound having small dielectric anisotropy shortens the response time of the device by decreasing viscosity of the composition. The compound extends the temperature range in which the device can be used by increasing the maximum temperature of the nematic phase.

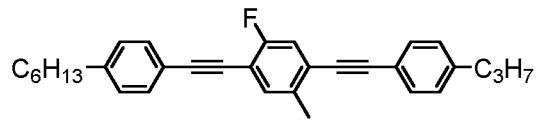
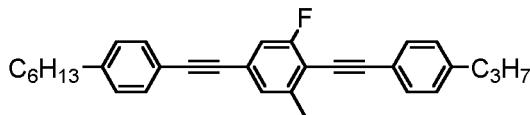
[0006] With regard to (7), a compound having a large elastic constant shortens the response time of the device. A compound having a small elastic constant decreases the threshold voltage of the device. Therefore, the suitable elastic constant is required according to the characteristics to be desirably improved. A compound having the good compatibility with other liquid crystal compounds as described in (8) is preferred. The reason is that the physical properties of the composition are adjusted by mixing liquid crystal compounds having different physical properties.

[0007] A variety of liquid crystal compounds having large dielectric anisotropy have been so far synthesized. A variety of liquid crystal compounds having a triple bond have also been synthesized. The reason is that good physical properties that are not found in conventional compounds are expected from a new compound. The reason is that the new compound may be occasionally provided with a suitable balance regarding at least two physical properties in the composition. In view of such a situation, with regard to the physical properties (1) to (8) described above, a compound having good physical properties and a suitable balance has been desired.

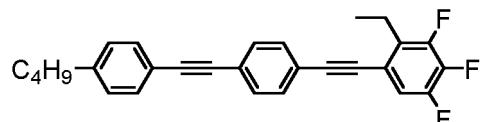
50 [0008] On page 75 (in the paragraph [0243]) of Patent literature No. 1, a compound as described below is disclosed.



[0009] On page 126 and page 128 of Patent literature No. 2, a compound as described below is disclosed.



[0010] On page 31 and page 128 of Patent literature No. 3, a compound as described below is disclosed.



Citation List

Patent Literature

[0011]

20 Patent literature No. 1: JP 2006-160727 A.
 Patent literature No. 2: WO 2012-126565 A.
 Patent literature No. 3: WO 2012-146340 A.

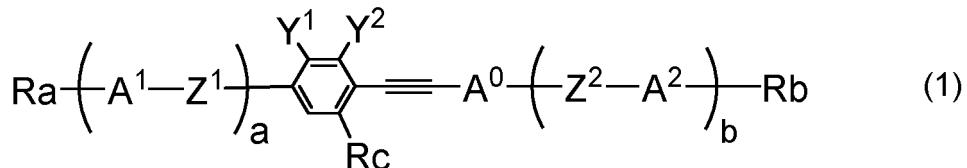
Summary of Invention

Technical Problem

[0012] A first object is to provide a liquid crystal compound satisfying at least one of physical properties such as high stability to heat or light, a high clearing point (or high maximum temperature of a nematic phase), low minimum temperature of a liquid crystal phase, small viscosity, suitable optical anisotropy, large dielectric anisotropy, a suitable elastic constant and good compatibility with other liquid crystal compounds. The object is to provide a compound having higher stability to light in comparison with a similar compound. A second object is to provide a liquid crystal composition that contains the compound and satisfies at least one of physical properties such as high stability to heat or light, high maximum temperature of the nematic phase, low minimum temperature of the nematic phase, small viscosity, suitable optical anisotropy, large dielectric anisotropy, large specific resistance and a suitable elastic constant. The object is to provide a liquid crystal composition having a suitable balance regarding at least two of the physical properties. A third object is to provide a liquid crystal display device including the composition and having a wide temperature range in which the device can be used, a short response time, a large voltage holding ratio, low threshold voltage, a large contrast ratio, a small flicker rate and a long service life.

Solution to Problem

[0013] The invention relates to a compound represented by formula (1), a liquid crystal composition containing the compound, and a liquid crystal display device including the composition.



50 In formula (1), Ra and Rb are independently hydrogen, fluorine, chlorine, -CN, -SF₅, -C≡C-SF₅ or alkyl having 1 to 20 carbons, and in the alkyl, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-; and at least one piece of -CH₂CH₂- may be replaced by -CH=CH- or -C≡C-, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; A⁰, A¹ and A² are independently 1,4-cyclohexylene, 1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-3,6-diyl, decahydronaphthalene-2,6-diyl, 1,2,3,4-tetrahydronaphthalene-2,6-diyl or naphthalene-2,6-diyl, and in the rings, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-; and at least one piece of

-CH₂CH₂- may be replaced by -CH=CH-, and in the groups, at least one hydrogen may be replaced by fluorine, chlorine, -CF₃, -CHF₂, -CH₂F, -OCF₃, -OCHF₂ or -OCH₂F; Z¹ and Z² are independently a single bond or alkylene having 1 to 4 carbons, and in the alkylene, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-; and at least one piece of -CH₂CH₂- may be replaced by -CH=CH-, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; one of Y¹ and Y² is fluorine, and the other is hydrogen; R_c is alkyl having 1 to 4 carbons, and in the alkyl, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-; and at least one piece of -CH₂CH₂- may be replaced by -CH=CH- or -C≡C-; and a and b are independently 0, 1, 2 or 3, and a sum of a and b is 0, 1, 2 or 3.

Advantageous Effects of Invention

[0014] A first advantage is to provide a liquid crystal compound satisfying at least one of physical properties such as high stability to heat or light, a high clearing point (or high maximum temperature of a nematic phase), low minimum temperature of a liquid crystal phase, small viscosity, suitable optical anisotropy, large dielectric anisotropy, a suitable elastic constant and good compatibility with other liquid crystal compounds. The advantage is to provide a compound having higher stability to light in comparison with a similar compound (see Comparative Examples 1 and 2). A second advantage is to provide a liquid crystal composition that contains the compound and satisfies at least one of physical properties such as high stability to heat or light, high maximum temperature of the nematic phase, low minimum temperature of the nematic phase, small viscosity, suitable optical anisotropy, large dielectric anisotropy, large specific resistance and a suitable elastic constant. The advantage is to provide a liquid crystal composition having a suitable balance regarding at least two of the physical properties. A third advantage is to provide a liquid crystal display device including the composition and having a wide temperature range in which the device can be used, a short response time, a large voltage holding ratio, low threshold voltage, a large contrast ratio, a small flicker rate and a long service life.

Description of Embodiments

[0015] Usage of terms herein is as described below. Terms "liquid crystal compound," "liquid crystal composition" and "liquid crystal display device" may be occasionally abbreviated as "compound," "composition" and "device," respectively. "Liquid crystal compound" is a generic term for a compound having a liquid crystal phase such as a nematic phase and a smectic phase, and a compound having no liquid crystal phase but to be added for the purpose of adjusting physical properties of a composition, such as maximum temperature, minimum temperature, viscosity and dielectric anisotropy. The compound has a six-membered ring such as 1,4-cyclohexylene and 1,4-phenylene, and has rod-like molecular structure. "Liquid crystal display device" is a generic term for a liquid crystal display panel and a liquid crystal display module. "Polymerizable compound" is a compound to be added for the purpose of forming a polymer in the composition.

[0016] The liquid crystal composition is prepared by mixing a plurality of liquid crystal compounds. An additive is added to the composition for the purpose of further adjusting the physical properties. The additive such as the polymerizable compound, a polymerization initiator, a polymerization inhibitor, an optically active compound, an antioxidant, an ultra-violet light absorber, a light stabilizer, a heat stabilizer, a dye and an antifoaming agent is added thereto when necessary. The liquid crystal compound and the additive are mixed in such a procedure. A proportion of the liquid crystal compound is expressed in terms of weight percent (% by weight) based on the weight of the liquid crystal composition containing no additive even after the additive has been added. A proportion of the additive is expressed in terms of weight percent (% by weight) based on the weight of the liquid crystal composition containing no additive. More specifically, a proportion of the liquid crystal compound or the additive is calculated based on the total weight of the liquid crystal compound. Weight parts per million (ppm) may be occasionally used. A proportion of the polymerization initiator and the polymerization inhibitor is exceptionally expressed based on the weight of the polymerizable compound.

[0017] "Clearing point" is a transition temperature between the liquid crystal phase and an isotropic phase in the liquid crystal compound. "Minimum temperature of the liquid crystal phase" is a transition temperature between a solid and the liquid crystal phase (the smectic phase, the nematic phase or the like) in the liquid crystal compound. "Maximum temperature of the nematic phase" is a transition temperature between the nematic phase and the isotropic phase in a mixture of the liquid crystal compound and a base liquid crystal or in the liquid crystal composition, and may be occasionally abbreviated as "maximum temperature." "Minimum temperature of the nematic phase" may be occasionally abbreviated as "minimum temperature." An expression "increase the dielectric anisotropy" means that a value of dielectric anisotropy positively increases in a composition having positive dielectric anisotropy, and the value of dielectric anisotropy negatively increases in a composition having negative dielectric anisotropy. An expression "having a large voltage holding ratio" means that the device has a large voltage holding ratio at room temperature and also at a temperature close to the maximum temperature in an initial stage, and the device has the large voltage holding ratio at room temperature and also at a temperature close to the maximum temperature even after the device has been used for a long period of time. In order to examine characteristics of a composition or a device, an ageing testing may be occasionally carried out.

[0018] A compound represented by formula (1) may be occasionally abbreviated as compound (1). At least one

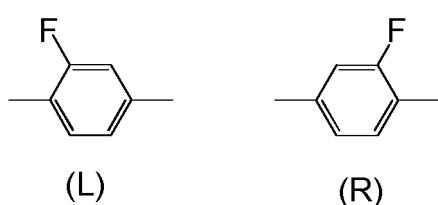
compound selected from the group of compounds represented by formula (1) may be occasionally abbreviated as compound (1). "Compound (1)" means one compound, a mixture of two compounds or a mixture of three or more compounds represented by formula (1). A same rule applies also to any other compound represented by any other formula. In formulas (1) to (15), a symbol of A^1 , B^1 , C^1 or the like represents a six-membered ring such as cyclohexane or benzene. The symbol may occasionally represents a fused ring such as naphthalene or a bridged ring such as adamantane.

[0019] A symbol of terminal group R^{11} is used in a plurality of compounds in chemical formulas of component compounds. In the compounds, two groups represented by two pieces of arbitrary R^{11} may be identical or different. For example, in one case, R^{11} of compound (2) is ethyl and R^{11} of compound (3) is ethyl. In another case, R^{11} of compound (2) is ethyl and R^{11} of compound (3) is propyl. A same rule applies also to a symbol of R^{12} , R^{13} , Z^{11} or the like. In compound (8), when a subscript 'i' is 2, two of ring D^1 exists. In the compound, two groups represented by two of ring D^1 may be identical or different. A same rule applies also to two of arbitrary ring D^1 when the subscript 'i' is larger than 2. A same rule applies also to other symbols.

[0020] An expression "at least one piece of 'A'" means that the number of 'A' is arbitrary. An expression "at least one piece of 'A'" may be replaced by 'B' means that, when the number of 'A' is 1, a position of 'A' is arbitrary, and also when the number of 'A' is 2 or more, positions thereof can be selected without restriction. A same rule applies also to an expression "at least one piece of 'A' is replaced by 'B'." An expression "at least one piece of 'A'" may be replaced by 'B', 'C' or 'D' includes a case where arbitrary 'A' is replaced by 'B', a case where arbitrary 'A' is replaced by 'C', and a case where arbitrary 'A' is replaced by 'D', and also a case where a plurality of pieces of 'A' are replaced by at least two pieces of 'B', 'C' and/or 'D'. For example, "alkyl in which at least one piece of $-CH_2-$ may be replaced by $-O-$ or $-CH=CH-$ " includes alkyl, alkoxy, alkoxyalkyl, alkenyl, alkoxyalkenyl and alkenyloxyalkyl. In addition, a case where two pieces of consecutive $-CH_2-$ are replaced by $O-$ to form $-O-O-$ is not preferred. In alkyl or the like, a case where $-CH_2-$ of a methyl part ($-CH_2-H$) is replaced by $O-$ to form $-O-H$ is not preferred, either.

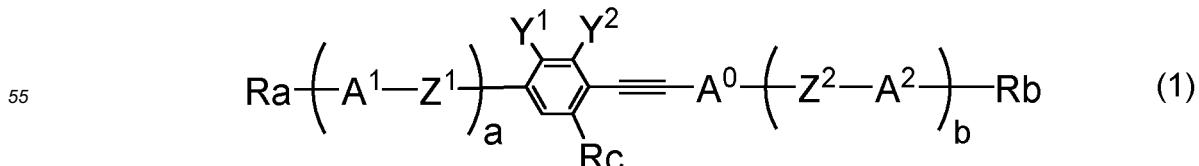
[0021] An expression " R^{11} and R^{12} are independently alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in the alkyl and the alkenyl, at least one piece of $-CH_2-$ may be replaced by $-O-$, and in the groups, at least one hydrogen may be replaced by fluorine" may be occasionally used. In the expression, "in the groups" may be interpreted according to wording. In the expression, "the groups" means alkyl, alkenyl, alkoxy, alkenyloxy or the like. More specifically, "the groups" represents all of the groups described before the term "in the groups." The common interpretation is applied also to terms of "in the monovalent groups" or "in the divalent groups." For example, "the monovalent groups" represents all of the groups described before the term "in the monovalent groups."

[0022] In the liquid crystal compound, alkyl is straight-chain alkyl or branched-chain alkyl, but includes no cyclic alkyl. In general, straight-chain alkyl is preferred to branched-chain alkyl. A same rule applies also to a terminal group such as alkoxy and alkenyl. "Fluoroalkyl" means alkyl in which at least one hydrogen is replaced by fluorine. The fluoroalkyl is a generic term of monofluoroalkyl, polyfluoroalkyl and perfluoroalkyl. A same rule applies also to fluoroalkoxy or the like. With regard to a configuration of 1,4-cyclohexylene, trans is generally preferred to cis. Then, 2-fluoro-1,4-phenylene means two divalent groups described below. In a chemical formula, fluorine may be leftward (L) or rightward (R). A same rule applies also to an asymmetrical divalent group induced by removing two hydrogens from a ring, such as tetrahydropyran-2,5-diyl.



[0023] The invention includes items described below.

50 Item 1. A compound, represented by formula (1):

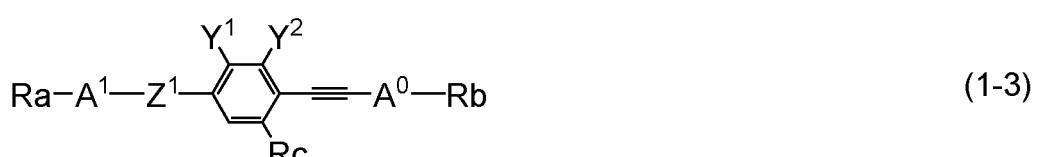
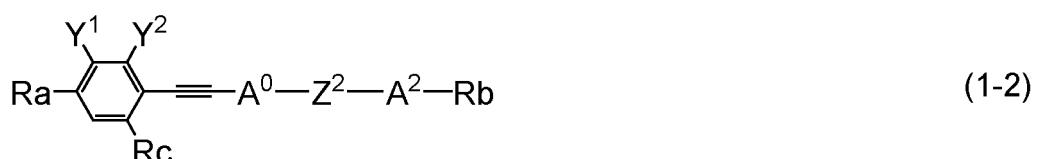


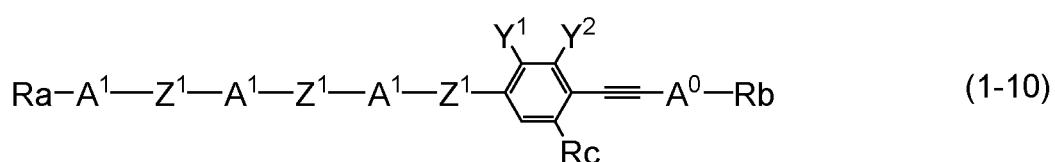
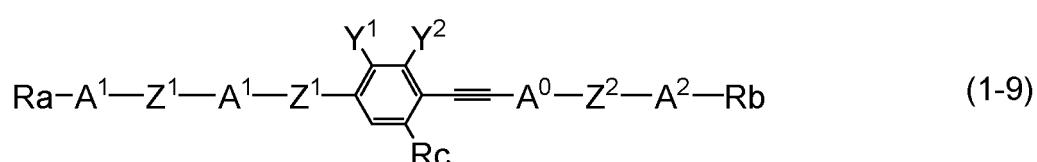
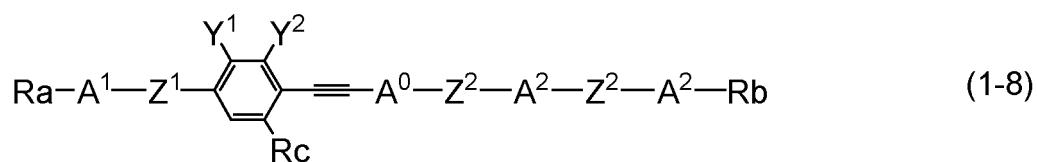
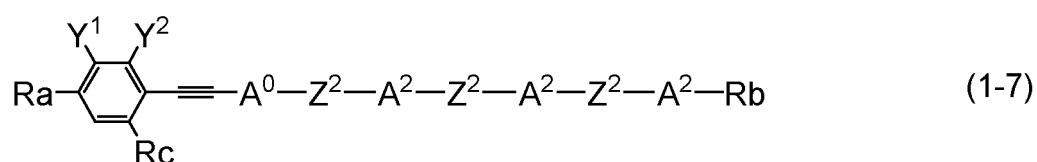
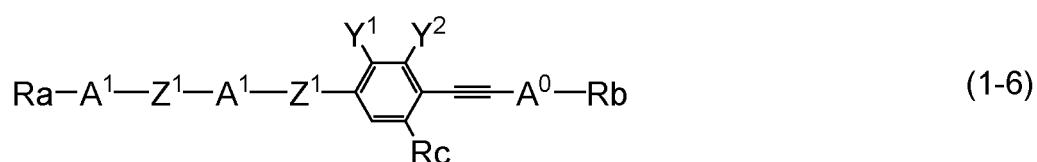
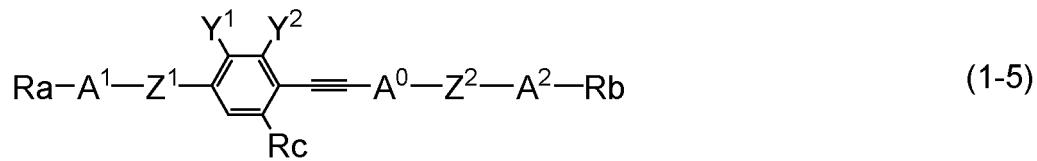
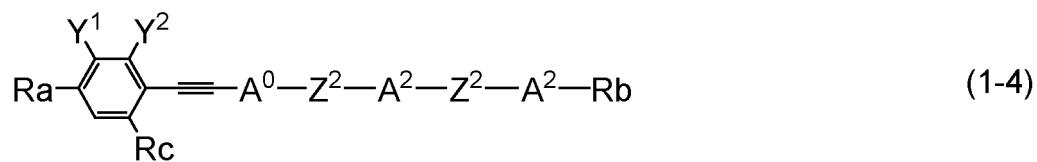
wherein, in formula (1), Ra and Rb are independently hydrogen, fluorine, chlorine, -CN, -SF₅, -C≡C-SF₅ or alkyl having 1 to 20 carbons, and in Ra and Rb, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-, and at least one piece of -CH₂CH₂- may be replaced by -CH=CH- or -C≡C-, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; A⁰, A¹ and A² are independently 1,4-cyclohexylene, 1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-3,6-diyl, decahydronaphthalene-2,6-diyl, 1,2,3,4-tetrahydronaphthalene-2,6-diyl or naphthalene-2,6-diyl, and in A⁰, A¹ and A², at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-, and at least one piece of -CH₂CH₂- may be replaced by -CH=CH-, and in the groups, at least one hydrogen may be replaced by fluorine, chlorine, -CF₃, -CHF₂, -CH₂F, -OCF₃, -OCHF₂ or -OCH₂F; Z¹ and Z² are independently a single bond or alkylene having 1 to 4 carbons, and in Z¹ and Z², at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-, and at least one piece of -CH₂CH₂- may be replaced by -CH=CH-, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; one of Y¹ and Y² is fluorine, and the other is hydrogen; Rc is alkyl having 1 to 4 carbons, and in Rc, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-, and at least one piece of -CH₂CH₂- may be replaced by -CH=CH- or -C≡C-; and a and b are independently 0, 1, 2 or 3, and a sum of a and b is 0, 1, 2 or 3.

Item 2. The compound according to item 1, wherein, in formula (1), Ra and Rb are independently fluorine, chlorine, alkyl having 1 to 20 carbons, alkoxy having 1 to 19 carbons, alkoxyalkyl having 2 to 19 carbons, alkenyl having 2 to 20 carbons, alkynyl having 2 to 20 carbons, fluoroalkyl having 1 to 20 carbons or fluoroalkoxy having 1 to 19 carbons; A⁰, A¹ and A² are independently 1,4-cyclohexylene, 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-3,6-diyl, naphthalene-2,6-diyl, 1-fluoronaphthalene-2,6-diyl, 1,3-difluoronaphthalene-2,6-diyl or 1,3,8-trifluoronaphthalene-2,6-diyl; Z¹ and Z² are independently a single bond, -CH₂CH₂-, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -CH₂CO-, -COCH₂-, -CH₂SiH₂-, -SiH₂CH₂-, -(CH₂)₂COO-, -OCO(CH₂)₂-, -(CH₂)₂CF₂O-, -OCF₂(CH₂)₂-, -(CH₂)₃O-, -O(CH₂)₃- or -(CH₂)₄-, one of Y¹ and Y² is fluorine, and the other is hydrogen; Rc is alkyl having 1 to 4 carbons, alkoxy having 1 to 3 carbons, alkoxyalkyl having 2 to 3 carbons or alkenyl having 2 to 4 carbons; and a and b are independently 0, 1, 2 or 3, and a sum of a and b is 0, 1, 2 or 3.

Item 3. The compound according to item 1, wherein, in formula (1), Ra and Rb are independently fluorine, alkyl having 1 to 20 carbons, alkoxy having 1 to 19 carbons, alkoxyalkyl having 2 to 19 carbons, alkenyl having 2 to 20 carbons, fluoroalkyl having 1 to 20 carbons or fluoroalkoxy having 1 to 19 carbons; A⁰, A¹ and A² are independently 1,4-cyclohexylene, 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-3,6-diyl, naphthalene-2,6-diyl, 1-fluoronaphthalene-2,6-diyl, 1,3-difluoronaphthalene-2,6-diyl or 1,3,8-trifluoronaphthalene-2,6-diyl; Z¹ and Z² are independently a single bond, -CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -(CH₂)₂CF₂O- or -OCF₂(CH₂)₂-, one of Y¹ and Y² is fluorine, and the other is hydrogen; Rc is alkyl having 1 to 4 carbons or alkoxy having 1 to 3 carbons; and a and b are independently 0, 1, 2 or 3, and a sum of a and b is 0, 1 or 2.

Item 4. The compound according to item 1, represented by any one of formula (1-1) to formula (1-10):





50 wherein, in formula (1-1) to formula (1-10), Ra and Rb are independently hydrogen, fluorine, chlorine or alkyl having 1 to 10 carbons, and in Ra and Rb, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$ or $-\text{C}=\text{C}-$, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; A^0 , A^1 and A^2 are independently 1,4-cyclohexylene, 1,4-phenylene, decahydronaphthalene-2,6-diyl, 1,2,3,4-tetrahydronaphthalene-2,6-diyl or naphthalene-2,6-diyl, and in the rings, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$, and in the rings, at least one hydrogen may be replaced by fluorine, chlorine, $-\text{CF}_3$, $-\text{CHF}_2$ or $-\text{CH}_2\text{F}$; Z^1 and Z^2 are independently a single bond or alkylene having 1 to 4 carbons, and in the alkylene, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$ or $-\text{CO}-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$, and in the groups, at least one hydrogen

55

may be replaced by fluorine or chlorine; one of Y¹ and Y² is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons, and in the alkyl, at least one piece of -CH₂- may be replaced by -O-, and at least one piece of -CH₂CH₂- may be replaced by -CH=CH- or -C≡C-.

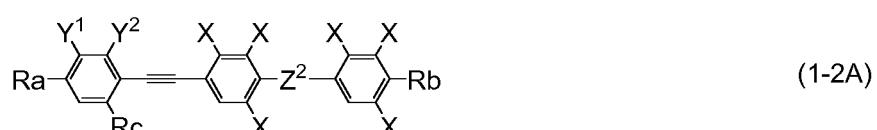
5 Item 5. The compound according to item 4, wherein, in formula (1-1) to formula (1-10), Ra and Rb are independently fluorine, alkyl having 1 to 10 carbons, alkoxy having 1 to 9 carbons, alkoxyalkyl having 2 to 9 carbons, alkenyl having 2 to 10 carbons, alkynyl having 2 to 10 carbons, fluoroalkyl having 1 to 10 carbons or fluoroalkoxy having 2 to 10 carbons; A⁰, A¹ and A² are independently 1,4-cyclohexylene, 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, naphthalene-2,6-diyl, 1-fluoronaphthalene-2,6-diyl, 1,3-difluoronaphthalene-2,6-diyl or 1,3,8-trifluoronaphthalene-2,6-diyl; Z¹ and Z² are independently a single bond, -CH₂CH₂-, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -(CH₂)₂COO-, -OCO(CH₂)₂-, -(CH₂)₂CF₂O-, -OCF₂(CH₂)₂-, -(CH₂)₃O-, -O(CH₂)₃ or -(CH₂)₄; one of Y¹ and Y² is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons, alkoxy having 1 to 4 carbons, alkoxyalkyl having 2 to 4 carbons or alkenyl having 2 to 4 carbons.

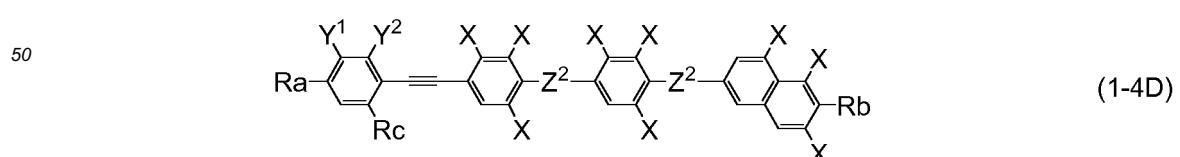
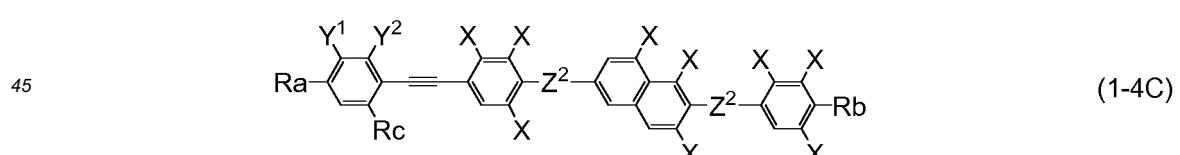
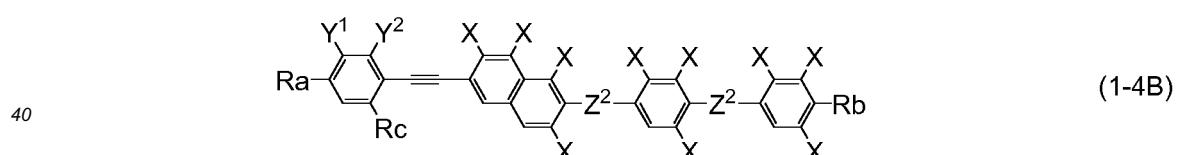
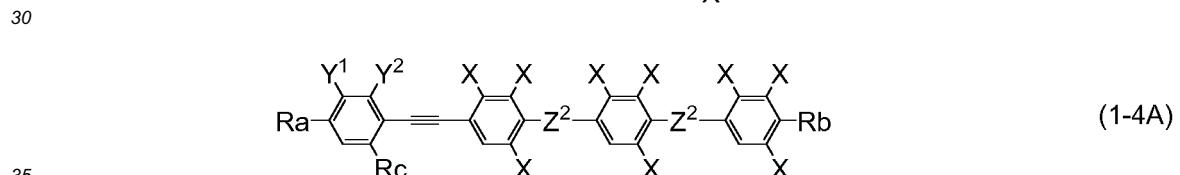
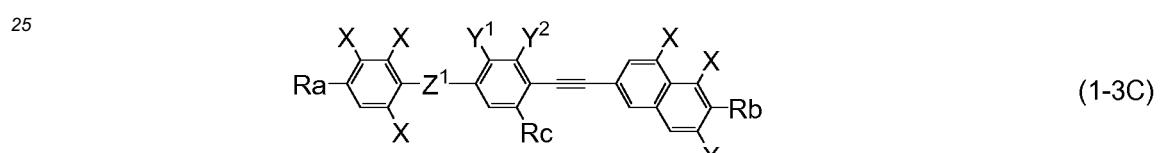
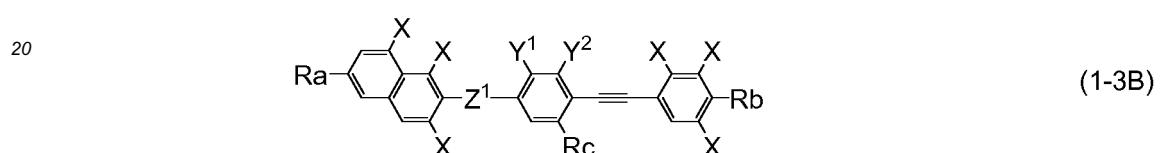
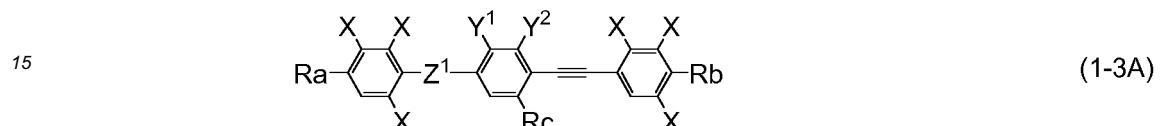
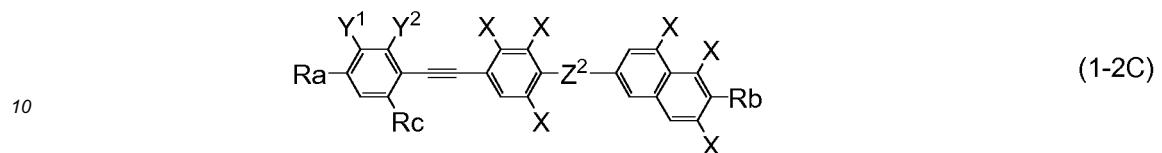
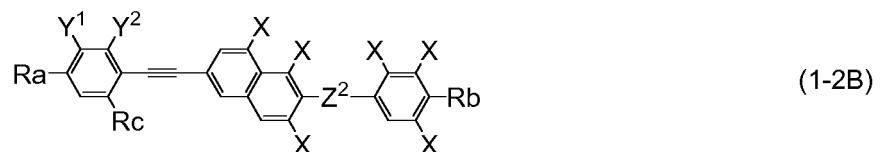
10 Item 6. The compound according to item 4, wherein, in formula (1-1) to formula (1-10), Ra and Rb are independently fluorine, alkyl having 1 to 10 carbons, alkoxy having 1 to 9 carbons, alkenyl having 2 to 10 carbons, fluoroalkyl having 1 to 10 carbons or fluoroalkoxy having 2 to 10 carbons; A⁰, A¹ and A² are independently 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, naphthalene-2,6-diyl, 1-fluoronaphthalene-2,6-diyl, 1,3-difluoronaphthalene-2,6-diyl or 1,3,8-trifluoronaphthalene-2,6-diyl; Z¹ and Z² are independently a single bond, -CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -(CH₂)₂CF₂O-, -OCF₂(CH₂)₂-, -(CH₂)₃O-, -O(CH₂)₃ or -(CH₂)₄; one of Y¹ and Y² is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons, alkoxy having 1 to 4 carbons, alkoxyalkyl having 2 to 4 carbons or alkenyl having 2 to 4 carbons.

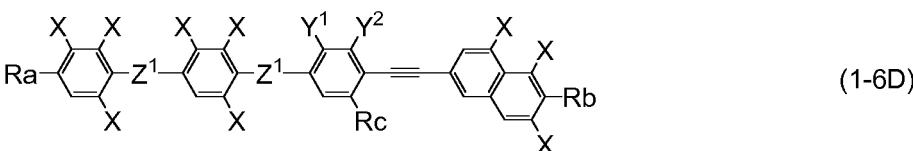
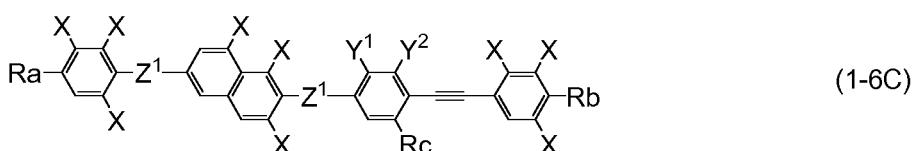
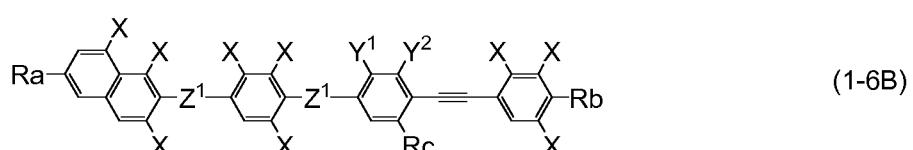
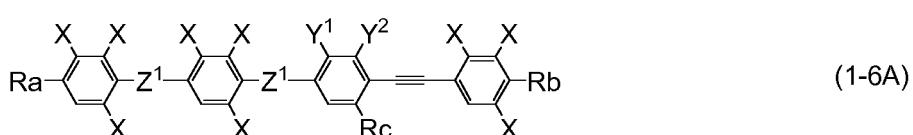
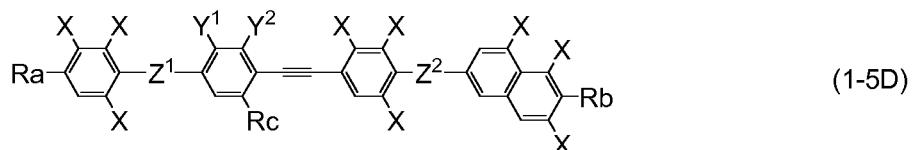
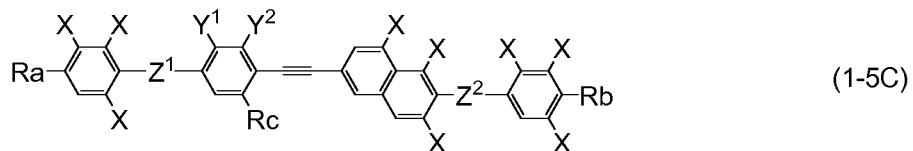
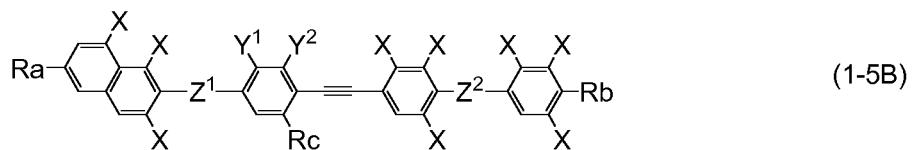
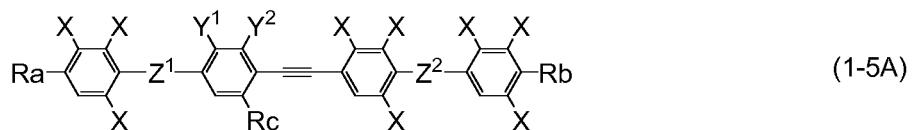
15 Item 7. The compound according to item 4, wherein, in formula (1-1) to formula (1-10), Ra and Rb are independently fluorine, alkyl having 1 to 8 carbons, alkoxy having 1 to 8 carbons, alkenyl having 2 to 8 carbons, fluoroalkyl having 1 to 8 carbons or fluoroalkoxy having 1 to 8 carbons; A⁰, A¹ and A² are independently 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, naphthalene-2,6-diyl, 1-fluoronaphthalene-2,6-diyl, 1,3-difluoronaphthalene-2,6-diyl or 1,3,8-trifluoronaphthalene-2,6-diyl; Z¹ and Z² are independently a single bond, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -(CH₂)₂CF₂O- or -OCF₂(CH₂)₂; one of Y¹ and Y² is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons or alkoxy having 1 to 4 carbons.

20 Item 8. The compound according to item 4, wherein, in formula (1-1) to formula (1-6), Ra and Rb are independently fluorine, alkyl having 1 to 8 carbons, alkoxy having 1 to 8 carbons or fluoroalkyl having 1 to 8 carbons; A⁰, A¹ and A² are independently 1,4-phenylene, 2-fluoro-1,4-phenylene or 2,6-difluoro-1,4-phenylene; Z¹ and Z² are independently a single bond, -CF₂O- or -OCF₂; one of Y¹ and Y² is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons.

25 Item 9. The compound according to item 1, represented by any one of formula (1-1A) to formula (1-1B), formula (1-2A) to formula (1-2C), formula (1-3A) to formula (1-3C), formula (1-4A) to formula (1-4D), formula (1-5A) to formula (1-5D) and formula (1-6A) to formula (1-6D):







50

wherein, in formula (1-1A) to formula (1-1B), formula (1-2A) to formula (1-2C), formula (1-3A) to formula (1-3C), formula (1-4A) to formula (1-4D), formula (1-5A) to formula (1-5D) and formula (1-6A) to formula (1-6D), Ra and Rb are independently hydrogen, fluorine, $-CF_3$, $-CHF_2$, $-CH_2F$, $-OCF_3$, $-OCHF_2$, $-OCF_2CHF_2$, $-OCF_2CHFCF_3$ or alkyl having 1 to 10 carbons, and in the alkyl, at least one piece of $-CH_2-$ may be replaced by $-O-$, and at least one piece of $-CH_2CH_2-$ may be replaced by $-CH=CH-$; Z¹ and Z² are independently a single bond, $-CF_2O-$ or $-OCF_2-$; one of Y¹ and Y² is fluorine, and the other is hydrogen; Rc is methyl, ethyl or propyl; and X is hydrogen or fluorine.

55

Item 10. The compound according to item 9, wherein, in formula (1-1A), formula (1-2A), formula (1-3A), formula (1-4A), formula (1-5A) or formula (1-6A), Ra and Rb are alkyl having 1 to 10 carbons or alkoxy having 1 to 10 carbons; Z¹ and Z² are a single bond; one of Y¹ and Y² is fluorine, and the other is hydrogen; Rc is methyl, ethyl or propyl; and X is hydrogen or fluorine.

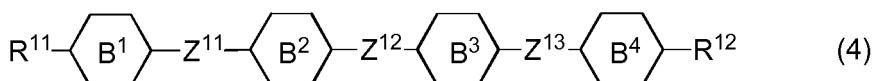
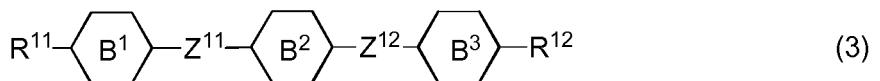
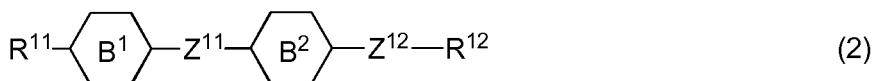
5 Item 11. The compound according to item 9, wherein, in formula (1-1B), formula (1-2B), formula (1-2C), formula (1-3B), formula (1-3C), formula (1-4B), formula (1-4C), formula (1-4D), formula (1-5B), formula (1-5C), formula (1-5D), formula (1-6B), formula (1-6C) or formula (1-6D), Ra and Rb are alkyl having 1 to 10 carbons or alkoxy having 1 to 10 carbons; Z¹ and Z² are a single bond; Rc is methyl, ethyl or propyl, one of Y¹ and Y² is fluorine, and the other is hydrogen; and X is hydrogen or fluorine.

10 Item 12. The compound according to item 9, wherein, in formula (1-1A), formula (1-2A), formula (1-3A), formula (1-4A), formula (1-5A) or formula (1-6A), one of Ra and Rb is fluorine, -CF₃ or -OCF₃, and the other is alkyl having 1 to 10 carbons or alkoxy having 1 to 10 carbons; Z¹ and Z² are a single bond, -CF₂O- or -OCF₂-, Rc is methyl, ethyl or propyl; one of Y¹ and Y² is fluorine, and the other is hydrogen; and X is hydrogen or fluorine.

15 Item 13. The compound according to item 9, wherein, in formula (1-1B), formula (1-2B), formula (1-2C), formula (1-3B), formula (1-3C), formula (1-4B), formula (1-4C), formula (1-4D), formula (1-5B), formula (1-5C), formula (1-5D), formula (1-6B), formula (1-6C) or formula (1-6D), one of Ra and Rb is fluorine, -CF₃ or -OCF₃, and the other is alkyl having 1 to 10 carbons or alkoxy having 1 to 10 carbons; Z¹ and Z² are a single bond, -CF₂O- or -OCF₂-, Rc is methyl, ethyl or propyl; one of Y¹ and Y² is fluorine, and the other is hydrogen; and X is hydrogen or fluorine.

Item 14. A liquid crystal composition, containing at least one compound according to any one of items 1 to 13.

Item 15. The liquid crystal composition according to item 14, further containing at least one compound selected from the group of compounds represented by formulas (2) to (4):



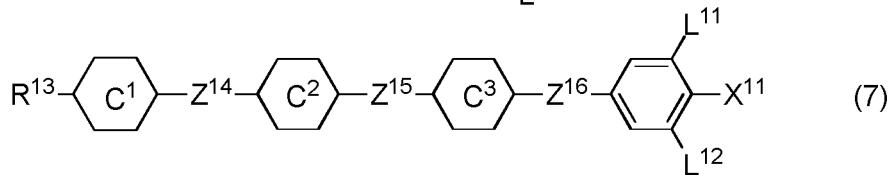
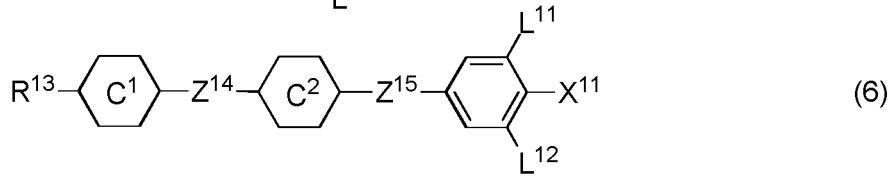
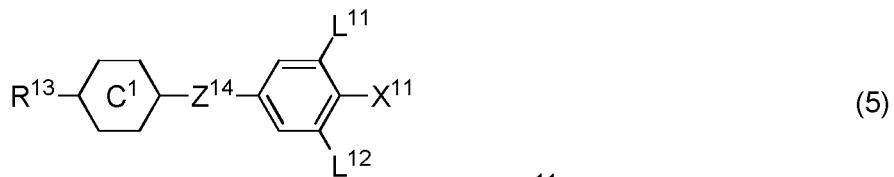
35 wherein, in formulas (2) to (4),

R¹¹ and R¹² are independently, alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in R¹¹ and R¹², at least one piece of -CH₂- may be replaced by -O-, and in the groups, at least one hydrogen may be replaced by fluorine;

35 ring B¹, ring B², ring B³ and ring B⁴ are independently 1,4-cyclohexylene, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene or pyrimidine-2,5-diy; and

Z¹¹, Z¹² and Z¹³ are independently a single bond, -COO-, -CH₂CH₂-, -CH=CH- or -C=C-.

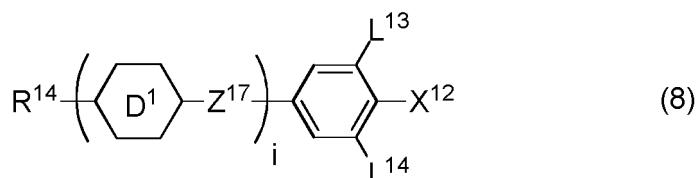
40 Item 16. The liquid crystal composition according to item 14 or 15, further containing at least one compound selected from the group of compounds represented by formulas (5) to (7):



wherein, in formulas (5) to (7),

20 R¹³ is alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in the alkyl and the alkenyl, at least one piece of -CH₂- may be replaced by -O-, and in the groups, at least one hydrogen may be replaced by fluorine; X¹¹ is fluorine, chlorine, -OCF₃, -OCHF₂, -CF₃, -CHF₂, -CH₂F, -OCF₂CHF₂ or -OCF₂CHFCF₃; 25 ring C¹, ring C² and ring C³ are independently 1,4-cyclohexylene, 1,4-phenylene, 1,4-phenylene in which at least one hydrogen is replaced by fluorine, tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl or pyrimidine-2,5-diyl; Z¹⁴, Z¹⁵ and Z¹⁶ are independently a single bond, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CH=CH-, -C≡C- or -(CH₂)₄-; and L¹¹ and L¹² are independently hydrogen or fluorine.

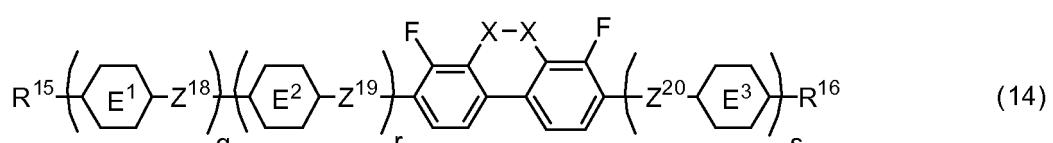
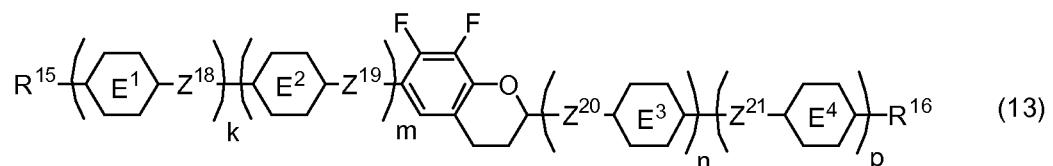
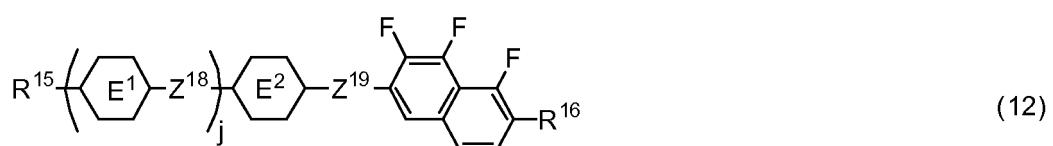
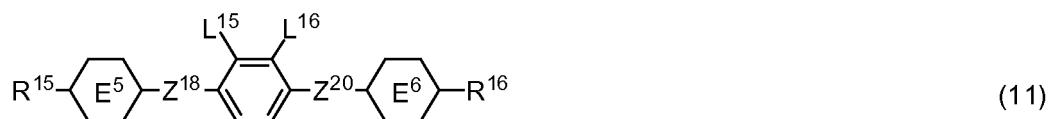
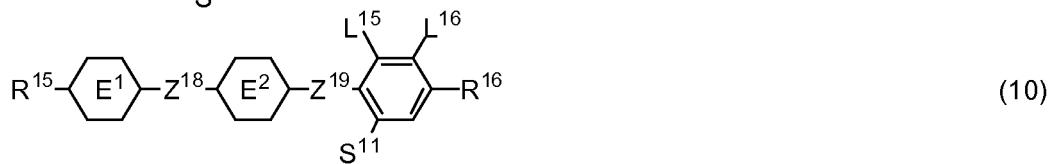
30 Item 17. The liquid crystal composition according to any one of items 14 to 16, further containing at least one compound selected from the group of compounds represented by formula (8) :



40 wherein, in formula (8),

R¹⁴ is alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in R¹⁴, at least one piece of -CH₂- may be replaced by -O-, and in the groups, at least one hydrogen may be replaced by fluorine; X¹² is -C≡N or -C≡C-C≡N; 45 ring D¹ is 1,4-cyclohexylene, 1,4-phenylene, 1,4-phenylene in which at least one hydrogen is replaced by fluorine, tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl or pyrimidine-2,5-diyl; Z¹⁷ is a single bond, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂- or -C≡C-; L¹³ and L¹⁴ are independently hydrogen or fluorine; and i is 1, 2, 3 or 4.

50 Item 18. The liquid crystal composition according to any one of items 14 to 17, further containing at least one compound selected from the group of compounds represented by formulas (9) to (15):



45 wherein, in formulas (9) to (15),

R¹⁵, R¹⁶ and R¹⁷ are independently alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in R¹⁵, R¹⁶ and R¹⁷, at least one piece of -CH₂- may be replaced by -O-, and in the groups, at least one hydrogen may be replaced by fluorine, in which R¹⁷ may be hydrogen or fluorine;

50 ring E¹, ring E², ring E³ and ring E⁴ are independently 1,4-cyclohexylene, 1,4-cyclohexenylene, 1,4-phenylene, 1,4-phenylene in which at least one hydrogen is replaced by fluorine, tetrahydropyran-2,5-diyl or decahydro-naphthalene-2,6-diyl;

ring E⁵ and ring E⁶ are independently 1,4-cyclohexylene, 1,4-cyclohexenylene, 1,4-phenylene, tetrahydropyran-2,5-diyl or decahydronaphthalene-2,6-diyl;

55 Z¹⁸, Z¹⁹, Z²⁰ and Z²¹ are independently a single bond, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CF₂OCH₂CH₂- or -OCF₂CH₂CH₂-;

L¹⁵ and L¹⁶ are independently fluorine or chlorine;

S¹¹ is hydrogen or methyl;

X is -CHF- or -CF₂-; and

j, k, m, n, p, q, r and s are independently 0 or 1, a sum of k, m, n and p is 1 or 2, a sum of q, r and s is 0, 1, 2 or 3, and t is 1, 2 or 3.

5 Item 19. A liquid crystal display device, including the liquid crystal composition according to any one of items 14 to 18.

Item 20. The liquid crystal display device according to item 19, wherein the liquid crystal composition according to any one of items 14 to 18 is encapsulated.

Item 21. The liquid crystal display device according to item 19, wherein the liquid crystal composition according to any one of items 14 to 18 is used in a lens to be utilized in switching between 2D and 3D.

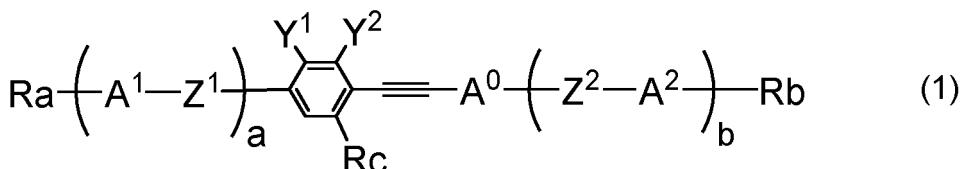
10 [0024] The invention further includes the following items: (a) the composition, further containing one, two or at least three additives selected from the group of a polymerizable compound, a polymerization initiator, a polymerization inhibitor, an optically active compound, an antioxidant, an ultraviolet light absorber, a light stabilizer, a heat stabilizer, a dye and an antifoaming agent; (b) the liquid crystal composition, wherein a maximum temperature of a nematic phase is 70°C or higher, an optical anisotropy (measured at 25°C) at a wavelength of 589 nanometers is 0.07 or more, and a dielectric anisotropy (measured at 25°C) at a frequency of 1 kHz is 2 or more; and (c) the liquid crystal display device, wherein an operating mode in the liquid crystal display device is a TN mode, an ECB mode, an OCB mode, an IPS mode, a VA mode, an FFS mode or an FPA mode, and a driving mode in the liquid crystal display device is an active matrix (AM) mode.

15 [0025] An aspect of compound (1), a synthesis method of compound (1), the liquid crystal composition and the liquid crystal display device will be described in the order.

20 1. Aspect of compound (1)

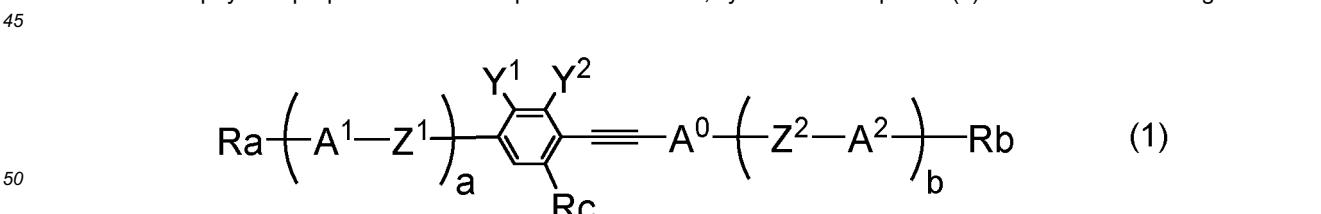
[0026] Compound (1) of the invention has a 1,4-phenylene ring in which Rc such as alkyl is replaced in 5-position.

25 Compound (1) has a feature of having higher stability to light in comparison with a similar compound (see Comparative Examples 1 and 2). In a compound having a triple bond, stability to light is generally decreased. However, Rc in the 5-position is effective in preventing decrease of the stability.



35 [0027] In compound (1), magnitude of dielectric anisotropy depends on a kind of terminal group (Ra or Rb). When the terminal group is an electron donating group such as alkyl, dielectric anisotropy of compound (1) is small. When at least one terminal group is an electron withdrawing group such as fluorine, dielectric anisotropy of compound (1) is positive and large.

40 [0028] Preferred examples of compound (1) will be described. Preferred examples of terminal group Ra, ring A and bonding group Z in compound (1) apply also to a subordinate formula of formula (1) for compound (1). In compound (1), physical properties can be arbitrarily adjusted by suitably combining the groups. Compound (1) may contain a larger amount of isotope such as ²H (deuterium) and ¹³C than the amount of natural abundance because no significant difference exists in the physical properties of the compound. In addition, symbols in compound (1) are defined according to item 1.



50 [0029] In formula (1), Ra and Rb are independently hydrogen, fluorine, chlorine, -CN, -SF₅, -C≡C-SF₅ or alkyl having 1 to 20 carbons, and in the alkyl, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-; and at least one piece of -CH₂CH₂- may be replaced by -CH=CH- or -C≡C-, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine.

55 [0030] "Alkyl in which at least one piece of -CH₂- may be replaced by -O- or -CO-" includes not only a group having -O- or -CO-, but also a group having -COO- or -OCO-. A same rule applies also to a ring and a bonding group. Examples

of Ra or Rb include hydrogen (-H), alkyl (-R), alkoxy (-OR), alkoxyalkyl $(-\text{CH}_2)_n\text{OR}$, alkoxyalkoxy $(-\text{O}(\text{CH}_2)_n\text{OR})$, alkylthio (-SR), alkylthioalkyl $(-\text{CH}_2)_n\text{SR}$, alkylthioalkoxy $(-\text{O}(\text{CH}_2)_n\text{SR})$, acyl (-COR), acylalkyl $(-\text{CH}_2)_n\text{COR}$, acyloxy $(-\text{OCOR})$, acyloxyalkyl $(-\text{CH}_2)_n\text{OCOR}$, alkoxy carbonyl (-COOR), alkoxy carbonylalkyl $(-\text{CH}_2)_n\text{COOR}$, alkenyl $(-\text{CH}_2)_n\text{CH=CH-R}$, alkenyloxy $(-\text{O}(\text{CH}_2)_n\text{CH=CH-R})$, alkenyloxyalkyl $(-\text{CH}_2)_n\text{O}(\text{CH}_2)_n\text{CH=CH-R}$, alkoxyalkenyl $(-\text{CH}_2)_n\text{CH=CH-OR}$, alkynyl $(-\text{CH}_2)_n\text{C}\equiv\text{C-R}$, alkynylloxy $(-\text{O}(\text{CH}_2)_n\text{C}\equiv\text{C-R})$, alkylsilyl $(-\text{SiH}_2\text{R})$ or alkylsilylalkyl $(-\text{CH}_2)_n\text{SiH}_2\text{R}$. Examples of Ra or Rb is also include the above described groups in which at least one hydrogen is replaced by fluorine, and preferably include fluoroalkyl or fluoroalkoxy.

[0031] Preferred Ra or Rb is alkyl, alkoxy, alkoxyalkyl, alkoxyalkoxy, alkenyl, alkenyloxy, alkenyloxyalkyl or alkoxyalkenyl. Preferred Ra or Rb is alkyl, alkoxy, alkoxyalkyl, alkoxyalkoxy, alkenyl, alkenyloxy, alkylthio or alkylthioalkyl.

Further preferred Ra or Rb is alkyl, alkoxy, alkoxyalkyl, alkenyl or alkenyloxy. Still further preferred Ra or Rb is also alkyl, alkoxy, alkenyl or alkenyloxy. Particularly preferred Ra or Rb is alkyl or alkenyl. Most preferred Ra or Rb is alkyl.

[0032] Preferred alkyl is $-\text{CH}_3$, $-\text{C}_2\text{H}_5$, $-\text{C}_3\text{H}_7$, $-\text{C}_4\text{H}_9$, $-\text{C}_5\text{H}_{11}$, $-\text{C}_6\text{H}_{13}$ or $-\text{C}_7\text{H}_{15}$.

[0033] Preferred alkoxy is $-\text{OCH}_3$, $-\text{OC}_2\text{H}_5$, $-\text{OC}_3\text{H}_7$, $-\text{OC}_4\text{H}_9$, $-\text{OC}_5\text{H}_{11}$, $-\text{OC}_6\text{H}_{13}$ or $-\text{OC}_7\text{H}_{15}$.

[0034] Preferred alkoxyalkyl is $-\text{CH}_2\text{OCH}_3$, $-\text{CH}_2\text{OC}_2\text{H}_5$, $-\text{CH}_2\text{OC}_3\text{H}_7$, $-(\text{CH}_2)_2\text{OCH}_3$, $-(\text{CH}_2)_2\text{OC}_2\text{H}_5$, $-(\text{CH}_2)_2\text{OC}_3\text{H}_7$, $-(\text{CH}_2)_3\text{OCH}_3$, $-(\text{CH}_2)_4\text{OCH}_3$ or $-(\text{CH}_2)_5\text{OCH}_3$.

[0035] Preferred alkenyl is $-\text{CH=CH}_2$, $-\text{CH=CHCH}_3$, $-\text{CH}_2\text{CH=CH}_2$, $-\text{CH=CHC}_2\text{H}_5$, $-\text{CH}_2\text{CH=CHCH}_3$, $-(\text{CH}_2)_2\text{CH=CH}_2$, $-\text{CH=CHC}_3\text{H}_7$, $-\text{CH}_2\text{CH=CHC}_2\text{H}_5$, $-(\text{CH}_2)_2\text{CH=CHCH}_3$ or $-(\text{CH}_2)_3\text{CH=CH}_2$.

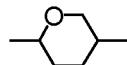
[0036] Preferred alkenyloxy is $-\text{OCH}_2\text{CH=CH}_2$, $-\text{OCH}_2\text{CH=CHCH}_3$ or $-\text{OCH}_2\text{CH=CHC}_2\text{H}_5$.

[0037] Preferred Ra or Rb is hydrogen, $-\text{CH}_3$, $-\text{C}_2\text{H}_5$, $-\text{C}_3\text{H}_7$, $-\text{C}_4\text{H}_9$, $-\text{C}_5\text{H}_{11}$, $-\text{C}_6\text{H}_{13}$, $-\text{OCH}_3$, $-\text{OC}_2\text{H}_5$, $-\text{OC}_3\text{H}_7$, $-\text{OC}_4\text{H}_9$, $-\text{OC}_5\text{H}_{11}$, $-\text{CH}_2\text{OCH}_3$, $-\text{CH=CH}_2$, $-\text{CH=CHCH}_3$, $-(\text{CH}_2)_2\text{CH=CH}_2$, $-\text{CH}_2\text{CH=CHC}_2\text{H}_5$, $-(\text{CH}_2)_2\text{CH=CHCH}_3$, $-\text{OCH}_2\text{CH=CH}_2$, $-\text{OCH}_2\text{CH=CHCH}_3$ or $-\text{OCH}_2\text{CH=CHC}_2\text{H}_5$. Further preferred Ra or Rb is $-\text{C}_3\text{H}_7$, $-\text{C}_4\text{H}_9$, $-\text{C}_5\text{H}_{11}$, $-\text{C}_6\text{H}_{13}$ or $-(\text{CH}_2)_2\text{CH=CH}_2$ - $(\text{CH}_2)_2\text{CH=CHCH}_3$.

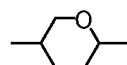
[0038] Both of Ra and Rb may be an electron withdrawing group, but one may be preferably the electron withdrawing group. Examples of the electron withdrawing group include fluorine, chlorine, $-\text{CN}$, $-\text{SF}_5$, $-\text{C}\equiv\text{C-SF}_5$, fluoroalkyl, fluoroalkoxy or fluoroalkoxyfluoroalkyl. Examples of fluoroalkyl or fluoroalkoxy include $-\text{CF}_3$, $-\text{CHF}_2$, $-\text{CH}_2\text{F}$, $-\text{OCF}_3$, $-\text{OCHF}_2$, $-\text{OCF}_2\text{CHF}_2$, $-\text{OCF}_2\text{CHFCF}_3$, perfluoroalkyl having 2 to 15 carbons or perfluoroalkoxy having 2 to 15 carbons. Examples of fluoroalkoxyfluoroalkyl include $-\text{CF}_2\text{OCF}_3$. A preferred electron withdrawing group is fluorine, $-\text{CF}_3$ or $-\text{OCF}_3$.

[0039] In formula (1), A^0 , A^1 and A^2 are independently 1,4-cyclohexylene, 1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-3,6-diyl, decahydronaphthalene-2,6-diyl, 1,2,3,4-tetrahydronaphthalene-2,6-diyl or naphthalene-2,6-diyl, and in the rings, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$ or $-\text{SiH}_2-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH=CH}-$, and in the groups, at least one hydrogen may be replaced by fluorine, chlorine, $-\text{CF}_3$, $-\text{CHF}_2$, $-\text{CH}_2\text{F}$, $-\text{OCF}_3$, $-\text{OCHF}_2$ or $-\text{OCF}_2\text{H}$.

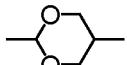
[0040] Preferred examples of "in the rings, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$ or $-\text{SiH}_2-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH=CH}-$ " include a divalent group represented by formulas (16-1) to (16-50) described below. Further preferred examples include the divalent group represented by formulas (16-1) to (16-4), formula (16-15), formula (16-23), formulas (16-27) to (16-29), formula (16-36), formula (16-39) and formula (16-45).



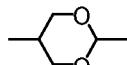
(16-1)



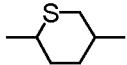
(16-2)



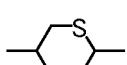
(16-3)



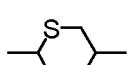
(16-4)



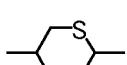
(16-5)



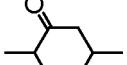
(16-6)



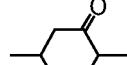
(16-7)



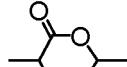
(16-8)



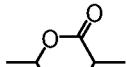
(16-9)



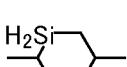
(16-10)



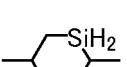
(16-11)



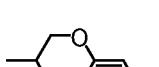
(16-12)



(16-13)

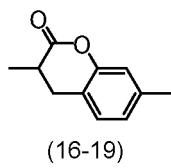
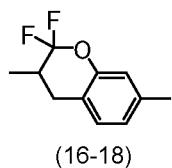
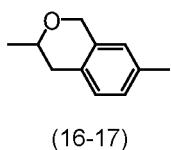
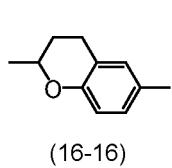


(16-14)

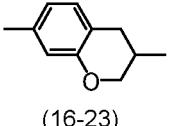
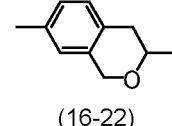
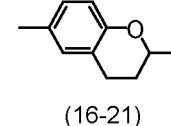
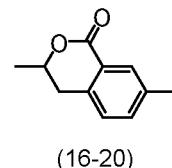


(16-15)

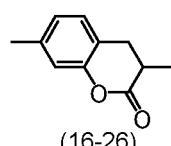
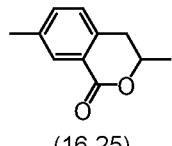
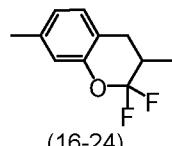
5



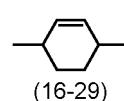
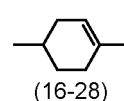
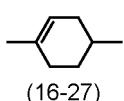
10



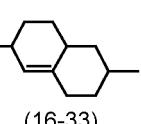
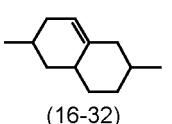
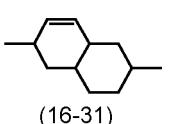
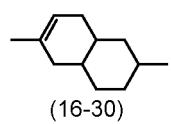
15



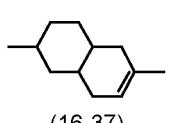
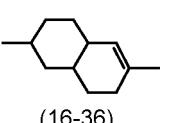
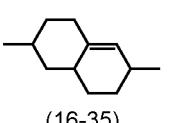
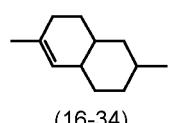
20



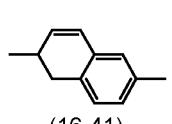
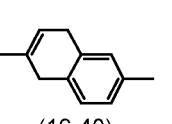
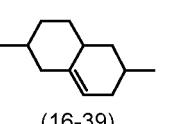
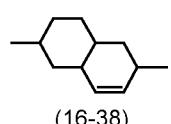
25



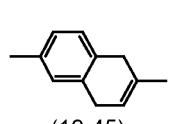
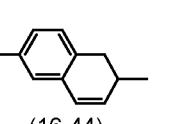
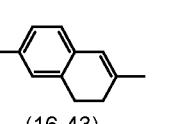
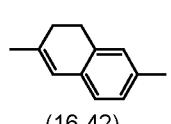
30



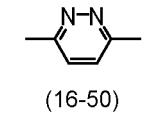
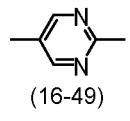
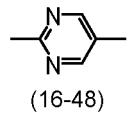
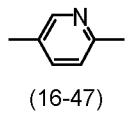
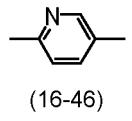
35



40



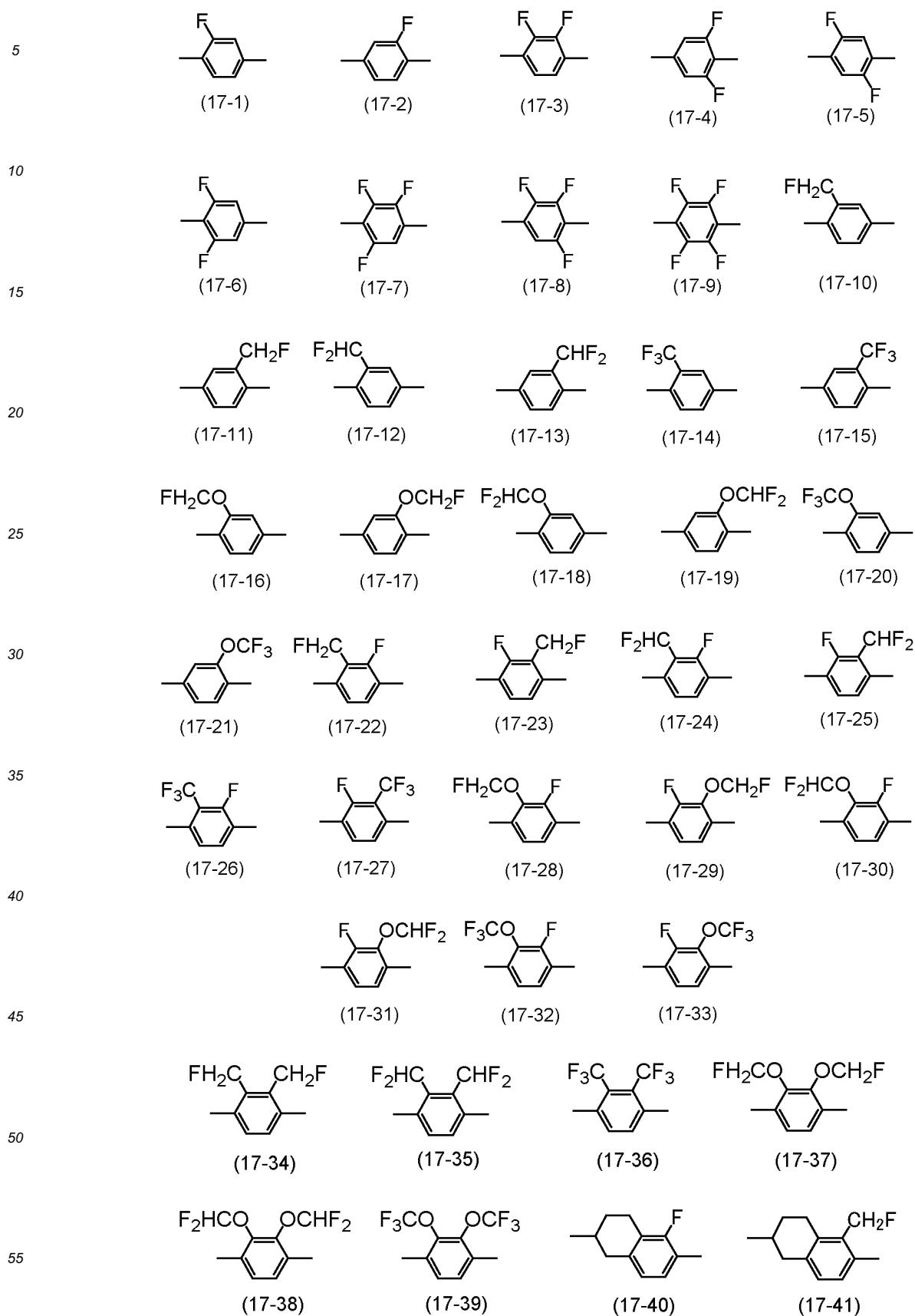
45

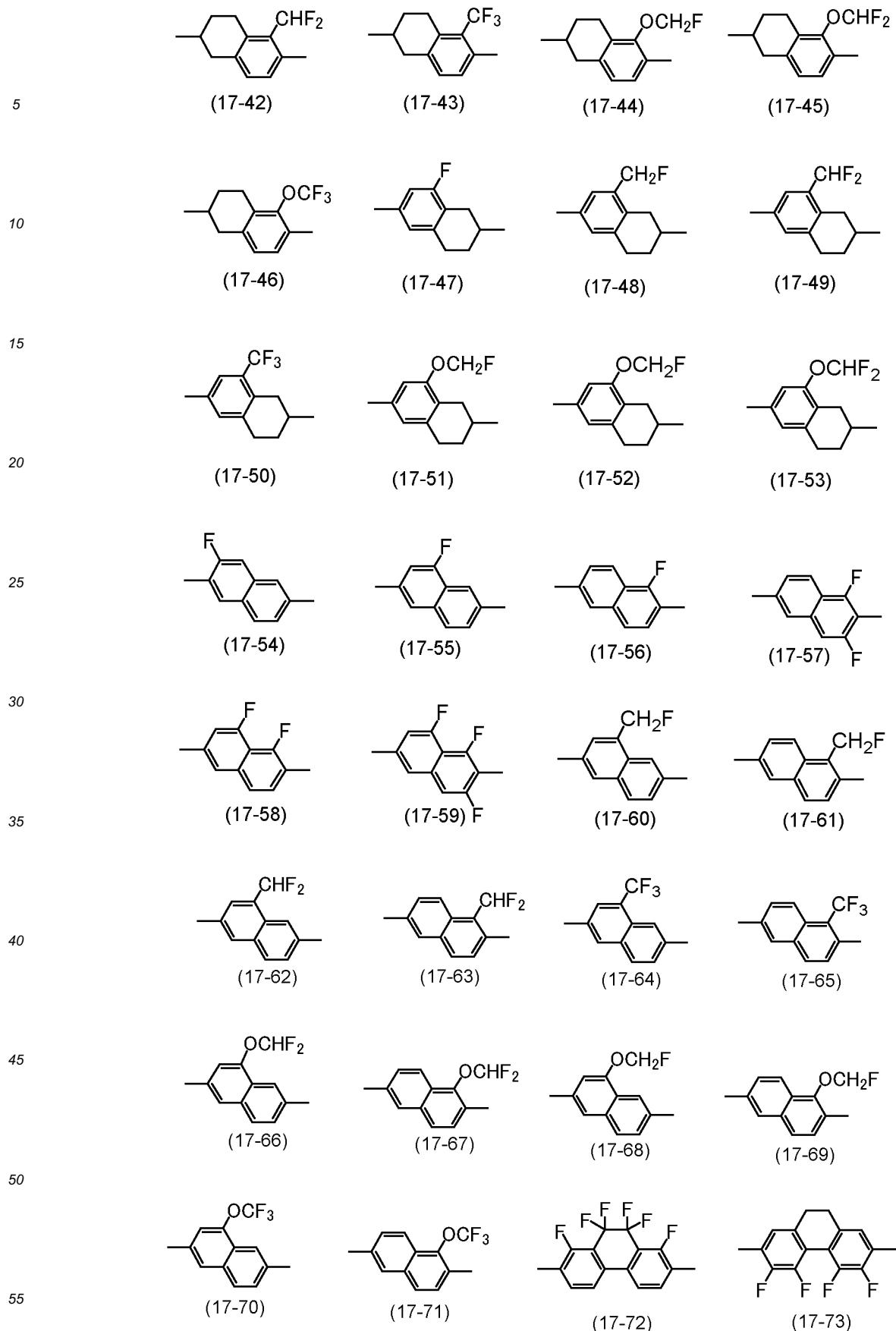


50

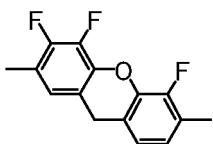
[0041] Preferred examples of "in the groups, at least one hydrogen may be replaced by fluorine, chlorine, -CF₃, -CHF₂, -CH₂F, -OCF₃, -OCHF₂ or -OCH₂F" include a divalent group represented by formulas (17-1) to (17-77) described below. Further preferred examples include the divalent group represented by formulas (17-1) to (17-4), formula (17-6), formulas

(17-10) to (17-15), formulas (17-54) to (17-59) and formulas (17-72) to (17-77).

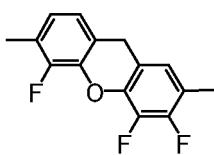




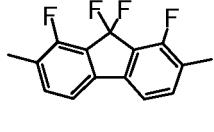
5



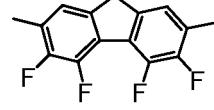
(17-74)



(17-75)



(17-76)



(17-77)

[0042] Preferred ring A⁰, A¹ or A² is 1,4-cyclohexylene, 1,4-cyclohexylene, tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,3-difluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, 2,3,5-trifluoro-1,4-phenylene, pyridine-2,5-diyl, 3-fluoropyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-2,5-diyl, decahydronaphthalene-2,6-diyl, 1,2,3,4-tetrahydronaphthalene-2,6-diyl or naphthalene-2,6-diyl. With regard to a configuration of 1,4-cyclohexylene and 1,3-dioxane-2,5-diyl, trans is preferred to cis.

[0043] A further preferred ring is 1,4-cyclohexylene, tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,3-difluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl or naphthalene-2,6-diyl. A particularly preferred ring is 1,4-cyclohexylene, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,3-difluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene or naphthalene-2,6-diyl. A most preferred ring is 1,4-cyclohexylene, 1,4-phenylene, 2-fluoro-1,4-phenylene or 2,6-difluoro-1,4-phenylene. A most preferred ring is also 1,4-cyclohexylene, 1,4-phenylene, 2-fluoro-1,4-phenylene or 2,3-difluoro-1,4-phenylene. A most preferred ring is also 1,4-cyclohexylene, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene or naphthalene-2,6-diyl.

[0044] In formula (1), Z¹ and Z² are independently a single bond or alkylene having 1 to 4 carbons, and in the alkylene, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-, and at least one piece of -CH₂CH₂- may be replaced by -CH=CH-, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine.

[0045] Preferred Z¹ or Z² is a single bond, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CH=CH-, -CF=CH-, -CH=CF-, -CF=CF-, -CH₂CO-, -COCH₂-, -CH₂SiH₂-, -SiH₂CH₂-, -(CH₂)₄-, -(CH₂)₂COO-, -(CH₂)₂OCO-, -OCO(CH₂)₂-, -COO(CH₂)₂-, -(CH₂)₂CF₂O-, -(CH₂)₂OCF₂-, -OCF₂(CH₂)₂-, -CF₂O(CH₂)₂-, -(CH₂)₃O- or -O(CH₂)₃-. With regard to a configuration of a double bond in a bonding group such as -CH=CH-, -CF=CF-, -CH=CH-CH₂O- and -OCH₂CH=CH-, trans is preferred to cis.

[0046] Further preferred Z¹ or Z² is a single bond, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CH=CH- or -(CH₂)₄-. Particularly preferred Z¹ or Z² is a single bond, -CH₂CH₂-, -COO-, -OCO-, -CF₂O-, -OCF₂- and -CH=CH-. Most preferred Z¹ or Z² is a single bond.

[0047] In formula (1), one of Y¹ and Y² is fluorine, and the other is hydrogen. A compound in which Y¹ is fluorine and Ra is the electron withdrawing group is preferred from a viewpoint of dielectric anisotropy. A compound in which Y² is fluorine and Rb is the electron withdrawing group is preferred from a viewpoint of dielectric anisotropy.

[0048] In formula (1), Rc is alkyl having 1 to 4 carbons, and in the alkyl, at least one piece of -CH₂- may be replaced by -O-, -S-, -CO- or -SiH₂-, and at least one piece of -CH₂CH₂- may be replaced by -CH=CH- or -C≡C-.

[0049] Preferred Rc is alkyl, alkoxy, alkoxyalkyl, alkoxyalkoxy, alkenyl, alkenyloxy, alkenyloxyalkyl or alkoxyalkenyl. Preferred Rc is also alkyl, alkoxy, alkoxyalkyl, alkoxyalkoxy, alkenyl, alkenyloxy, alkylthio, alkylthioalkyl, fluoroalkyl or fluoroalkoxy. Further preferred Rc is alkyl, alkoxy, alkoxyalkyl, alkenyl or alkenyloxy. Still further preferred Rc is also alkyl, alkoxy, alkenyl or alkenyloxy. Particularly preferred Rc is alkyl or alkenyl. Most preferred Rc is alkyl.

[0050] Preferred Rc is -CH₃, -C₂H₅, -C₃H₇, -C₄H₉, -OCH₃, -OC₂H₅, -OC₃H₇, -OC₄H₉, -CH₂OCH₃, -CH=CH₂, -CH=CHCH₃, -(CH₂)₂-CH=CH₂, -CH₂CH=CHC₂H₅, -(CH₂)₂-CH=CHCH₃, -OCH₂CH=CH₂, -OCH₂CH=CHCH₃ or -OCH₂CH=CHC₂H₅. Further preferred Rc is -CH₃, -C₂H₅, -C₃H₇, -OCH₃, -OC₂H₅, -OC₃H₇, -CH₂OCH₃ or -CH=CH₂. Particularly preferred Rc is -CH₃, -C₂H₅, -OCH₃ or -OC₂H₅.

[0051] In formula (1), a and b are independently 0, 1, 2 or 3, and a sum of a and b is 0, 1, 2 or 3. More specifically, compound (1) has a bicyclic ring to a pentacyclic ring. The rings include a fused ring in addition to a six-membered ring such as 1,4-phenylene. Such a ring is also counted as a monocyclic ring. When compound (1) has the bicyclic ring, compatibility with other liquid crystal compounds is good. When compound (1) has the bicyclic ring or a tricyclic ring, the viscosity is low. When compound (1) has the tricyclic ring or a tetracyclic ring, the maximum temperature is high. When compound (1) has the tetracyclic ring, the temperature range of the liquid crystal phase is wide.

[0052] Physical properties such as optical anisotropy and dielectric anisotropy can be arbitrarily adjusted by suitably selecting a terminal group, a ring and a bonding group in compound (1). An effect of kinds of the groups for providing physical properties of compound (1) will be described below.

[0053] When terminal group Ra or Rb has a straight chain, the temperature range of liquid crystal phase is wide and the viscosity is low. When Ra or Rb has a branched chain, compatibility with other liquid crystal compounds is good. A compound in which Ra or Rb is optically active is useful as a chiral dopant. A reverse twisted domain to be generated in the liquid crystal display device can be prevented by adding the compound to the composition. A compound in which Ra or Rb is not optically active is useful as a component of the composition. When Ra or Rb is alkenyl, a preferred

configuration depends on a position of a double bond. An alkenyl compound having the preferred configuration has low viscosity, high maximum temperature or the wide temperature range of the liquid crystal phase.

[0054] A preferred configuration of $-\text{CH}=\text{CH}-$ in the alkenyl depends on a position of a double bond. A trans configuration is preferred in alkenyl having the double bond in an odd-numbered position, such as $-\text{CH}=\text{CHCH}_3$, $-\text{CH}=\text{CHC}_2\text{H}_5$, $-\text{CH}=\text{CHC}_3\text{H}_7$, $-\text{CH}=\text{CHC}_4\text{H}_9$, $-\text{C}_2\text{H}_4\text{CH}=\text{CHCH}_3$ and $-\text{C}_2\text{H}_4\text{CH}=\text{CHC}_2\text{H}_5$. A cis configuration is preferred in alkenyl having the double bond in an even-numbered position, such as $-\text{CH}_2\text{CH}=\text{CHCH}_3$, $-\text{CH}_2\text{CH}=\text{CHC}_2\text{H}_5$ and $-\text{CH}_2\text{CH}=\text{CHC}_3\text{H}_7$. The alkenyl compound having the preferred configuration has a high clearing point or the wide temperature range of the liquid crystal phase. A detailed description is found in Mol. Cryst. Liq. Cryst., 1985, 131, 109, and Mol. Cryst. Liq. Cryst., 1985, 131, 327.

[0055] When ring A⁰, A¹ or A² is 1,4-phenylene in which at least one hydrogen is replaced by fluorine or chlorine, pyridine-2,5-diyl or 1,3-dioxane-2,5-diyl, dielectric anisotropy is positively large. When the ring thereof is 1,4-phenylene in which at least one hydrogen may be replaced by fluorine or chlorine, pyridine-2,5-diyl, pyrimidine-2,5-diyl or pyridazine-3,6-diyl, the optical anisotropy is large. When the ring thereof is 1,4-cyclohexylene, 1,4-cyclohexenylene or 1,3-dioxane-2,5-diyl, the optical anisotropy is small.

[0056] When at least two rings are 1,4-cyclohexylene, the maximum temperature is high, the optical anisotropy is small, and the viscosity is small. When at least one ring is 1,4-phenylene, the optical anisotropy is comparatively large and an orientational order parameter is large. When at least two rings are 1,4-phenylene, the optical anisotropy is large, the temperature range of the liquid crystal phase is wide, and the maximum temperature is high.

[0057] When bonding group Z^1 or Z^2 is a single bond, $-\text{CH}_2\text{O}-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CF}=\text{CF}-$ or $-(\text{CH}_2)_4-$, the viscosity is small. When the bonding group is a single bond, $-\text{OCF}_2-$, $-\text{CF}_2\text{O}-$, $-\text{CH}_2\text{CH}_2-$ or $-\text{CH}=\text{CH}-$, the viscosity is further small. When the bonding group is $-\text{CH}=\text{CH}-$, the temperature range of the liquid crystal phase is wide, and an elastic constant ratio K_{33} / K_{11} (K_{33} : a bend elastic constant, K_{11} : a splay elastic constant) is large. When the bonding group is $-\text{C}=\text{C}-$, the optical anisotropy is large.

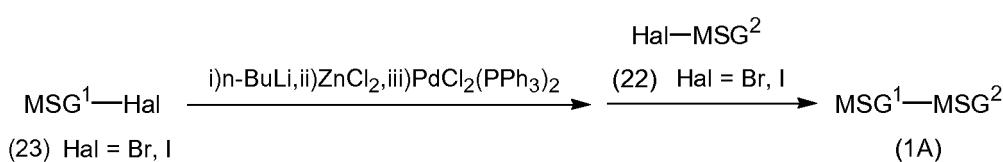
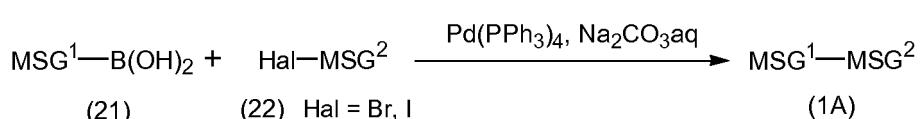
[0058] When compound (1) has the bicyclic ring or the tricyclic ring, the viscosity is small. When compound (1) has the tetracyclic ring or the pentacyclic ring, the maximum temperature is high. As described above, a compound having objective physical properties can be obtained by suitably selecting a kind of the terminal group, the ring and the bonding group, and the number of the rings. Accordingly, compound (1) is useful as a component of a composition used in a device having a mode such as the PC mode, the TN mode, the STN mode, the ECB mode, the OCB mode, the IPS mode and the VA mode.

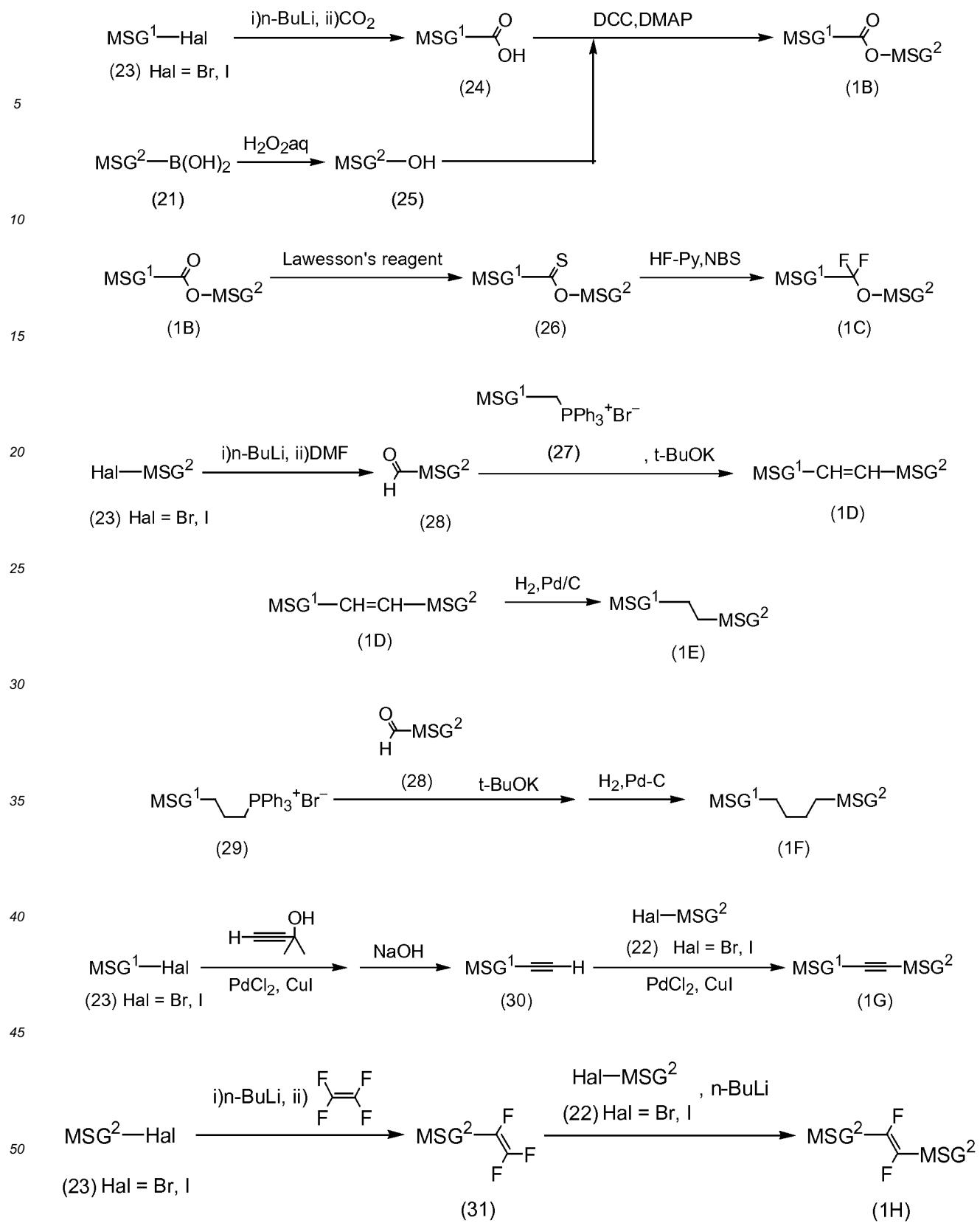
2. Synthesis of compound (1)

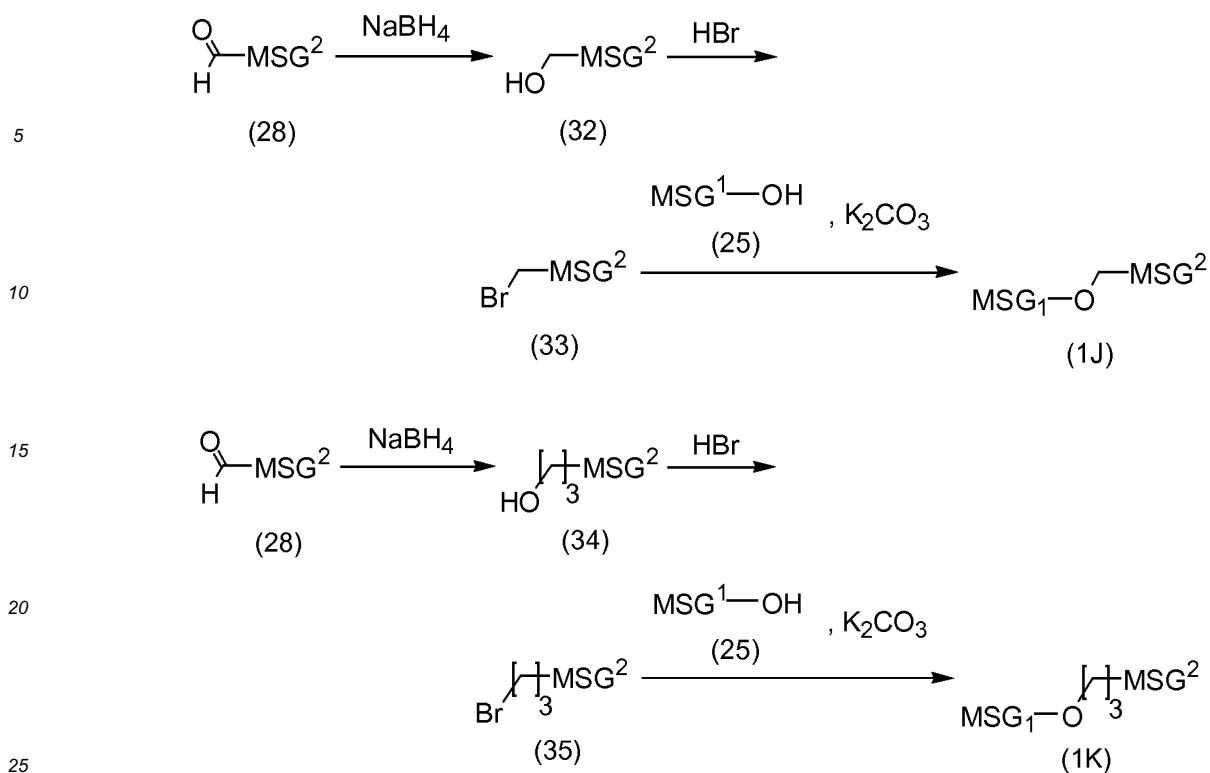
[0059] A synthesis method of compound (1) will be described. Compound (1) can be prepared by suitably combining methods in organic synthetic chemistry. A method for introducing a required terminal group, ring and bonding group into a starting material is described in books such as "Organic Syntheses" (John Wiley & Sons, Inc.), "Organic Reactions" (John Wiley & Sons, Inc.), "Comprehensive Organic Synthesis" (Pergamon Press) and "New Experimental Chemistry Course (Shin Jikken Kagaku Koza in Japanese)" (Maruzen Co., Ltd.).

2-1. Formation of bonding group Z

[0060] First, a scheme is shown with regard to a method for forming bonding group Z^1 or Z^2 . Next, reactions described in the scheme will be described in formations (1) to (11). In the scheme, MSG^1 (or MSG^2) is a monovalent organic group having at least one ring. A plurality of MSG^1 (or MSG^2) used in the scheme may be identical or different. Compounds (1A) to (1K) correspond to compound (1).







(1) Formation of a single bond

[0061] Compound (1A) is prepared by allowing aryl boronic acid (21) to react, in an aqueous solution of carbonate, with compound (22) prepared according to a publicly known method in the presence of a catalyst such as tetrakis(triphenylphosphine)palladium. Compound (1A) is also prepared by allowing compound (23) prepared according to a publicly known method to react with n-butyllithium and subsequently with zinc chloride, and further with compound (22) in the presence of a catalyst such as dichlorobis(triphenylphosphine)palladium.

35 (2) Formation of -OCO- and -COO-

[0062] Carboxylic acid (24) is obtained by allowing compound (23) to react with n-butyllithium and subsequently with carbon dioxide. Compound (1B) having -COO- is prepared by dehydration of carboxylic acid (24) and phenol (25) prepared according to a publicly known method in the presence of 1,3-dicyclohexylcarbodiimide (DCC) and 4-dimethylaminopyridine (DMAP). A compound having -OCO- can also be prepared according to the method.

(3) Formation of $-\text{CF}_2\text{O}-$ and $-\text{OCF}_2-$

[0063] Compound (26) is obtained by treating compound (1B) with a thiation reagent such as Lawesson's reagent. Compound (1C) having $-CF_2O-$ is prepared by fluorinating compound (26) with a hydrogen fluoride-pyridine complex and N-bromosuccinimide (NBS). Refer to M. Kuroboshi et al., Chem. Lett., 1992, 827. Compound (1C) can also be prepared by fluorinating compound (26) with (diethylamino)sulfur trifluoride (DAST). Refer to W. H. Bunnelle et al., J. Org. Chem. 1990, 55, 768. A compound having $-OCF_2-$ can also be prepared according to the method. The bonding groups can also be formed according to a method described in Peer. Kirsch et al., Angew. Chem. Int. Ed. 2001, 40, 1480.

(4) Formation of $-\text{CH}=\text{CH}-$

[0064] Aldehyde (28) is obtained by treating compound (23) with n-butyllithium and then allowing the treated compound to react with formamide such as N,N-dimethylformamide (DMF). Compound (1D) is prepared by allowing phosphorus ylide generated by treating phosphonium salt (27) prepared according to a publicly known method with a base such as potassium t-butoxide to react with aldehyde (28). A cis isomer may be generated depending on reaction conditions, and therefore the cis isomer is isomerized into a trans isomer according to a publicly known method when necessary.

(5) Formation of -CH₂CH₂-

[0065] Compound (1E) is prepared by hydrogenating compound (1D) in the presence of a catalyst such as palladium on carbon.

5

(6) Formation of -(CH₂)₄-

[0066] A compound having -(CH₂)₂-CH=CH- is obtained by using phosphonium salt (29) in place of phosphonium salt (27) according to the method in section (IV). Compound (1F) is prepared by performing catalytic hydrogenation of the compound obtained.

10

(7) Formation of -C≡C-

[0067] Compound (30) is obtained by allowing compound (23) to react with 2-methyl-3-butyn-2-ol in the presence of a catalyst of dichloropalladium and copper halide, and then performing deprotection under basic conditions. Compound (1G) is prepared by allowing compound (30) to react with compound (22) in the presence of the catalyst of dichloropalladium and copper halide.

15

(8) Formation of -CF=CF-

20

[0068] Compound (31) is obtained by treating compound (23) with n-butyllithium and then allowing the treated compound to react with tetrafluoroethylene. Compound (1H) is prepared by treating compound (22) with n-butyllithium and then allowing the treated compound to react with compound (31).

25

(9) Formation of -CH₂O- and -OCH₂-

[0069] Compound (32) is obtained by reducing aldehyde (28) with a reducing agent such as sodium borohydride. Compound (33) is obtained by halogenizing compound (32) with hydrobromic acid or the like. Compound (1J) is prepared by allowing compound (33) to react with compound (25) in the presence of potassium carbonate or the like.

30

(10) Formation of -(CH₂)₃O- and -O(CH₂)₃-

[0070] Compound (1K) is prepared by using compound (34) in place of compound (32) according to the method in section (9).

35

(11) Formation of -CF₂CF₂-

[0071] A compound having -(CF₂)₂- is obtained by fluorinating diketone (-COCO-) with sulfur tetrafluoride, in the presence of a hydrogen fluoride catalyst, according to a method described in J. Am. Chem. Soc., 2001, 123, 5414.

40

2-2. Formation of ring A

45

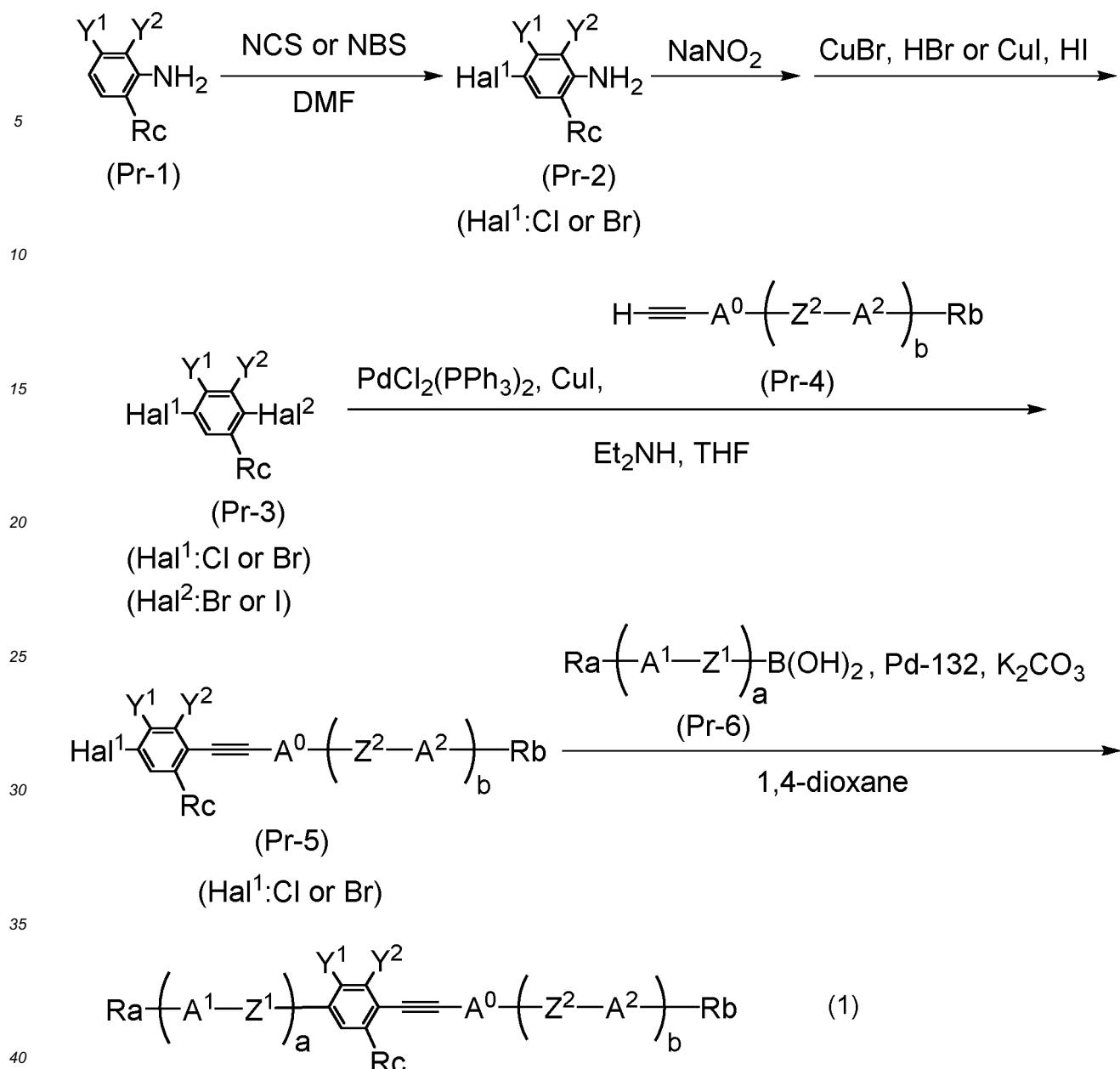
[0072] With regard to a ring such as 1,4-cyclohexylene, 1,4-phenylene, 2-fluoro-1,4-phenylene and 2,6-difluoro-1,4-phenylene, a starting material is commercially available or formation method thereof is well known. With regard to the formation of tetrahydropyran-2,5-diyl, see paragraphs from [0084] to [0107] in JP 2013-241397 A. With regard to the formation of 1,3-dioxane-2,5-diyl, see paragraphs from [0096] to [0119] in JP 2009-132927 A. With regard to the formation of pyrimidine-2,5-diyl and pyridine-2,5-diyl, see paragraphs from [0086] to [0094] in WO 2010/047260 A.

50

2-3. Method for preparing compound (1)

[0073] An example of a method for preparing compound (1) in which Z¹ is a single bond is as described below. In compound (1) in which Z¹ is any other bonding groups, a variety of compounds can be prepared by suitably selecting a synthetic intermediate.

55



[0074] Compound (Pr-1) is prepared according to a publicly known method. Compound (Pr-2) is derived from halogenating compound (Pr-1) by using N-chlorosuccinimide (NCS) or N-bromosuccinimide (NBS). Compound (Pr-3) in which an amino group is replaced by halogen is derived therefrom by performing a Sandmeyer reaction. On the other hand, compound (Pr-4) having a triple bond is prepared according to a publicly known method. Compound (Pr-5) is derived from the compound obtained and a halide by performing a Sonogashira reaction. Compound (1) is derived from compound (Pr-5) and compound (Pr-6) by performing a Suzuki-Miyaura coupling reaction.

3. Liquid crystal composition

50

3-1. Component compound

55

[0075] A liquid crystal composition of the invention will be described. The composition contains at least one compound (1) as component A. The composition may contain two, three or more compounds (1). A component in the composition may be only compound (1). In order to develop excellent physical properties, the composition preferably contains at least one of compounds (1) in the range of about 1% by weight to about 99% by weight based on the weight of the liquid crystal composition. When the dielectric anisotropy of compound (1) is small, a preferred proportion of compound (1) is about 5% by weight or more based thereon. A further preferred proportion is about 10% by weight or more or about 20%

by weight or more based thereon. On the other hand, in a composition having positive dielectric anisotropy, when the dielectric anisotropy of compound (1) is large, a preferred proportion of compound (1) is in the range of about 5% by weight to about 60% by weight based thereon. In a composition having negative dielectric anisotropy, a preferred proportion of compound (1) is about 30% by weight or less based thereon.

5

Table 1. Dielectric anisotropy of component compound

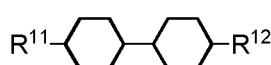
Component of composition	Component compound	Dielectric anisotropy
Component A	Compound (1) ¹⁾	Small or positively large
Component B	Compound (2) to compound (4)	Small
Component C	Compound (5) to compound (7)	Positively large
Component D	Compound (8)	Positively large
Component E	Compound (9) to compound (15)	Negatively large

1) Dielectric anisotropy of compound (1) may occasionally be small or positively large depending on a kind of terminal group Ra or Rb.

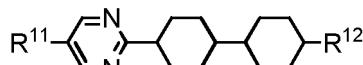
20 [0076] The composition contains compound (1) as component A, and further preferably contains a liquid crystal compound selected from components B, C, D and E shown in Table 1. When the composition is prepared, components B, C, D and E are preferably selected by taking into account the positive or negative dielectric anisotropy and magnitude of the dielectric anisotropy. The composition may contain a liquid crystal compound different from compounds (1) to (15). The composition may not contain such a liquid crystal compound.

25 [0077] Component B is a compound in which two terminal groups are alkyl or the like. Specific examples of preferred component B include compounds (2-1) to (2-11), compounds (3-1) to (3-19) and compounds (4-1) to (4-7). In the compounds, R¹¹ and R¹² are independently alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in the alkyl and the alkenyl, at least one piece of -CH₂- may be replaced by -O-, and in the groups, at least one hydrogen may be replaced by fluorine.

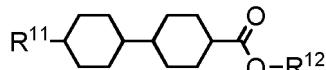
30



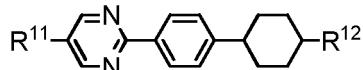
(2-1)



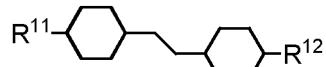
(3-9)



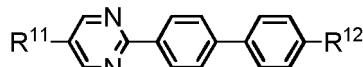
(2-2)



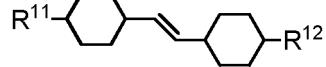
(3-10)



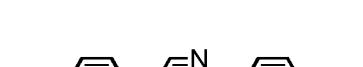
(2-3)



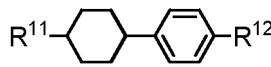
(3-11)



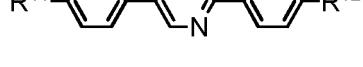
(2-4)



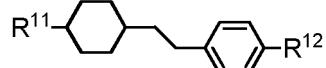
(3-12)



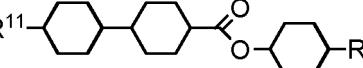
(2-5)



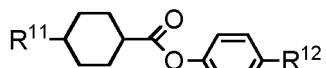
(3-13)



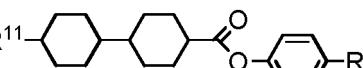
(2-6)



(3-14)



(2-7)

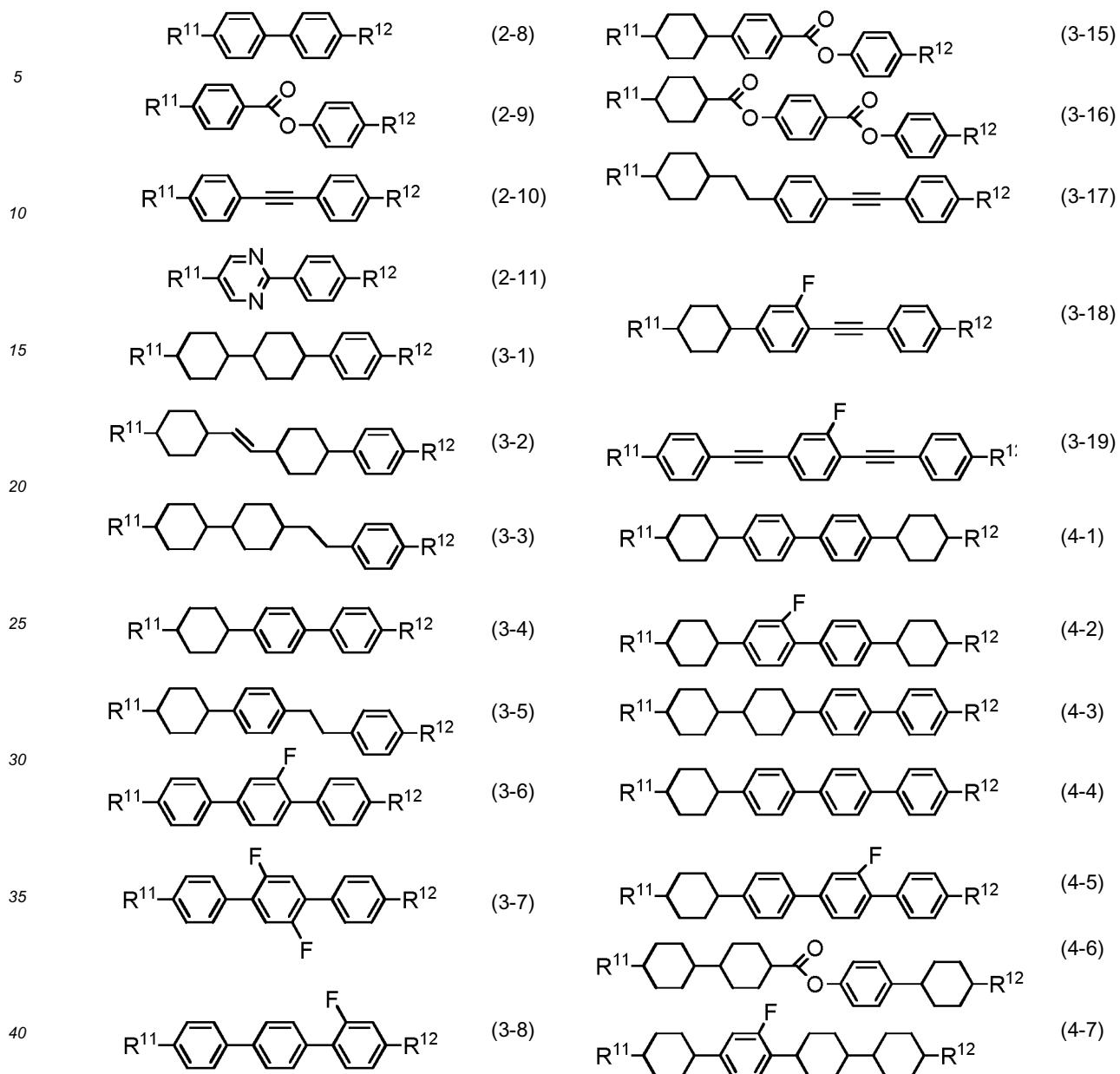


(3-14)

50

55

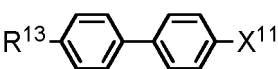
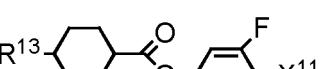
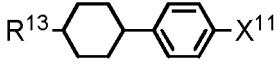
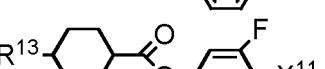
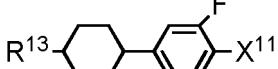
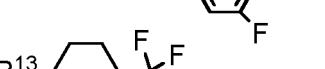
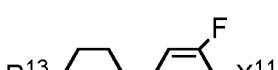
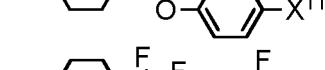
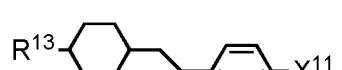
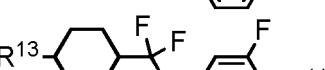
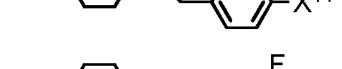
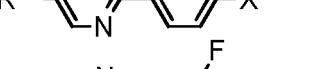
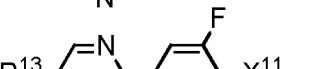
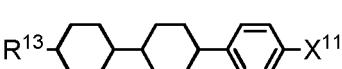
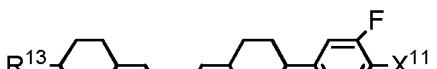
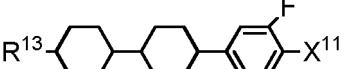
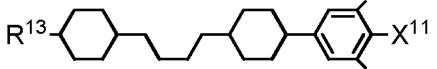
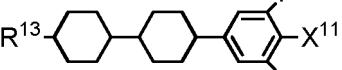
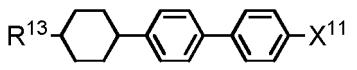
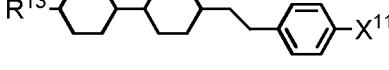
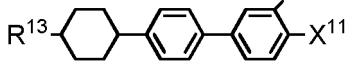
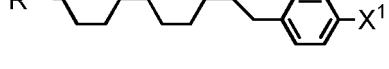
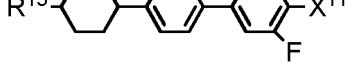
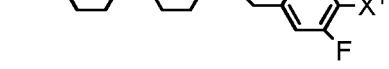
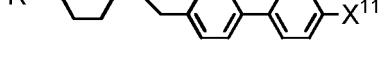
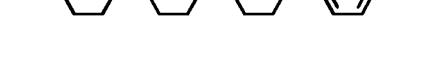
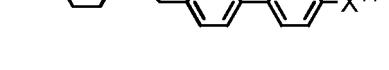
(continued)



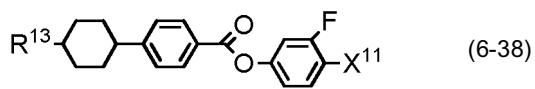
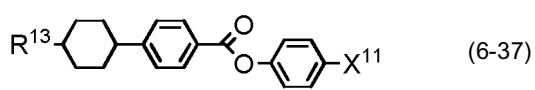
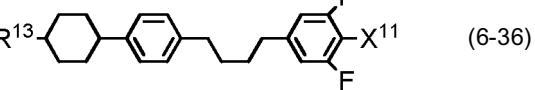
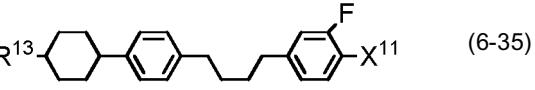
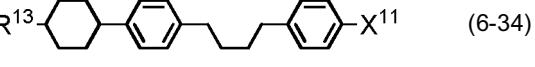
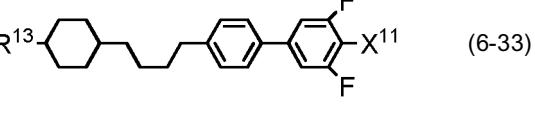
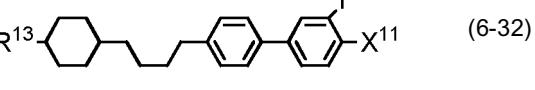
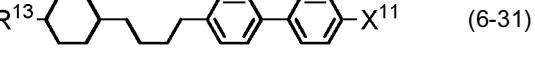
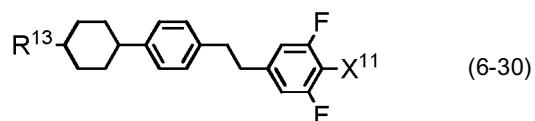
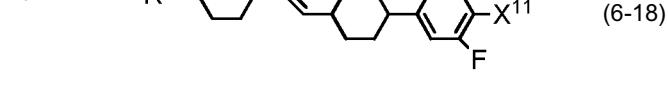
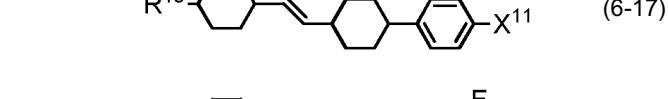
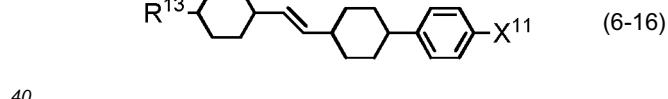
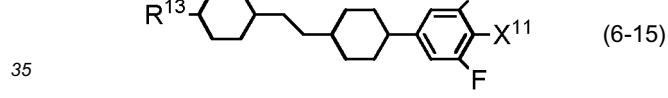
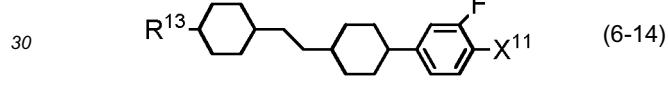
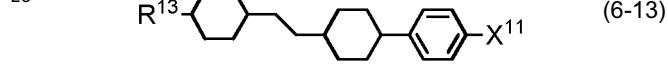
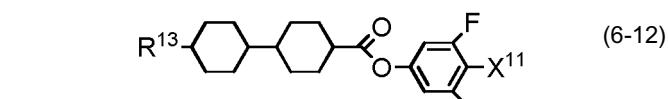
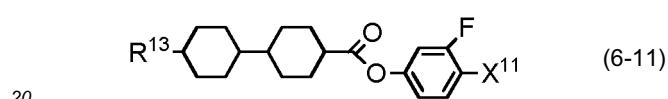
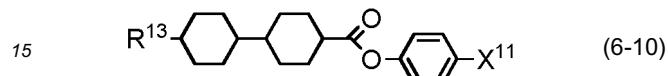
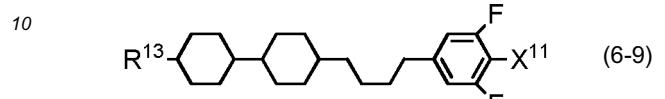
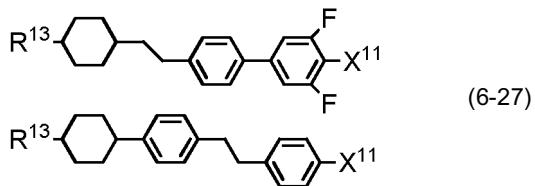
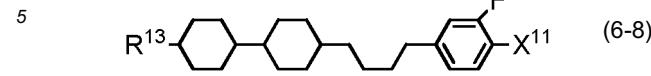
[0078] Component B has small dielectric anisotropy. Component B is close to neutrality. Compound (2) is effective in decreasing the viscosity or adjusting the optical anisotropy. Compounds (3) and (4) are effective in extending the temperature range of the nematic phase by increasing the maximum temperature, or adjusting the optical anisotropy.

[0079] As a proportion of component B is increased, the viscosity of the composition is decreased, but the dielectric anisotropy is decreased. Thus, as long as a desired value of threshold voltage of a device is met, the proportion is preferably as large as possible. When a composition for the IPS mode, the VA mode or the like is prepared, the proportion of component B is preferably about 30% by weight or more, and further preferably about 40% by weight or more, based thereon.

[0080] Component C is a compound having a halogen-containing group or a fluorine-containing group at a right terminal. Specific examples of preferred component C include compounds (5-1) to (5-16), compounds (6-1) to (6-113) and compounds (7-1) to (7-57). In the compounds, R¹³ is alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in the alkyl or the alkenyl, at least one piece of -CH₂- may be replaced by -O-, and in the groups, at least one hydrogen may be replaced by fluorine, X¹¹ is fluorine, chlorine, -OCF₃, -OCHF₂, -CF₃, -CHF₂, -CH₂F, -OCF₂CHF₂ or -OCF₂CHFCF₃.

		(5-1)		(5-9)
5		(5-2)		(5-10)
10		(5-3)		(5-11)
15		(5-4)		(5-12)
20		(5-5)		(5-13)
25		(5-6)		(5-14)
30		(5-7)		(5-15)
35		(5-8)		(5-16)
40		(6-1)		(6-20)
45		(6-2)		(6-21)
50		(6-3)		(6-22)
55		(6-4)		(6-23)
		(6-5)		(6-24)
		(6-6)		(6-25)
		(6-7)		(6-26)

(continued)



(continued)

5		(6-39)		(6-58)
10		(6-40)		(6-59)
15		(6-41)		(6-60)
20		(6-42)		(6-61)
25		(6-43)		(6-62)
30		(6-44)		(6-63)
35		(6-45)		(6-64)
40		(6-46)		(6-65)
45		(6-47)		(6-66)
50		(6-48)		(6-67)
		(6-49)		(6-68)
		(6-50)		(6-69)
		(6-51)		(6-70)
		(6-52)		(6-71)
		(6-53)		(6-72)
		(6-54)		(6-73)
		(6-55)		(6-74)
		(6-56)		(6-75)
		(6-57)		(6-76)

(continued)

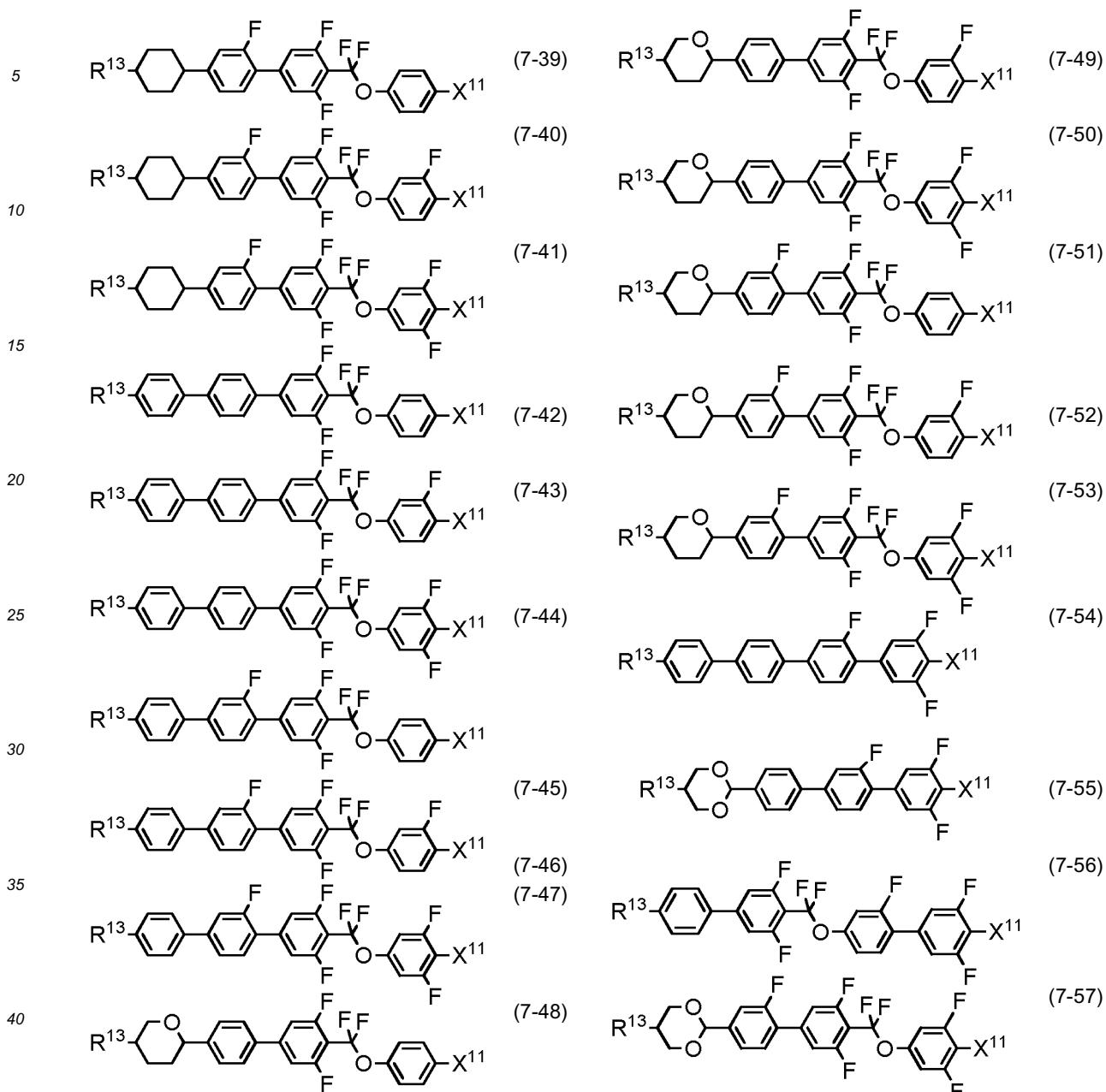
5		(6-77)		(6-96)
		(6-78)		(6-97)
10		(6-79)		(6-98)
		(6-80)		(6-99)
15		(6-81)		(6-100)
		(6-82)		(6-101)
20		(6-83)		(6-102)
		(6-84)		(6-103)
25		(6-85)		(6-104)
		(6-86)		(6-105)
30		(6-87)		(6-106)
		(6-88)		(6-107)
35		(6-89)		(6-108)
		(6-90)		(6-109)
40		(6-91)		(6-110)
		(6-92)		(6-111)
45		(6-93)		(6-112)
		(6-94)		(6-113)
50		(6-95)		

(continued)

5	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)X11</chem>
10	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)F-X11</chem>
15	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)F-F-X11</chem>
20	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)F-F-F-X11</chem>
25	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)F-F-F-F-X11</chem>
30	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)F-F-F-F-F-X11</chem>
35	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)F-F-F-F-F-X11</chem>
40	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)C(=O)Oc5ccc(cc5)-c6ccc(cc6)X11</chem>
45	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)C(F)(F)Oc5ccc(cc5)-c6ccc(cc6)X11</chem>
	<chem>R13-c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)-c4ccc(cc4)C(F)(F)Oc5ccc(cc5)-c6c(F)cc(F)c6Oc7ccc(cc7)X11</chem>

(7-1)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)X11</chem>	(7-21)
(7-2)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-22)
(7-3)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-23)
(7-4)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-24)
(7-5)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-25)
(7-6)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-26)
(7-7)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-27)
(7-8)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-28)
(7-9)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-29)
(7-10)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-30)
(7-11)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	
(7-12)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-31)
	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	
(7-13)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-32)
(7-14)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-33)
(7-15)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-34)
(7-16)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-35)
(7-17)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-36)
(7-18)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-37)
(7-19)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	
(7-20)	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	(7-38)
	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	
	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	
	<chem>R13c1ccc(cc1)-c2ccc(cc2)-c3ccc(cc3)C(F)(F)Oc4ccc(cc4)F</chem>	

(continued)



[0081] Component C has positive dielectric anisotropy and significantly good stability to heat or light, and therefore is used when a composition for the IPS mode, the FFS mode, the OCB mode or the like is prepared. A proportion of component C is suitably in the range of about 1% by weight to about 99% by weight, preferably in the range of about 10% by weight to about 97% by weight, and further preferably in the range of about 40% by weight to about 95% by weight, based thereon. When component C is added to a composition having negative dielectric anisotropy, the proportion of component C is preferably about 30% by weight or less based thereon. Addition of component C allows adjustment of the elastic constant of the composition and adjustment of a voltage-transmittance curve of the device.

[0082] Component D is compound (8) in which a right terminal group is $-\text{C}\equiv\text{N}$ or $-\text{C}\equiv\text{C}-\text{C}\equiv\text{N}$. Specific examples of preferred component D include compounds (8-1) to (8-64). In the compounds, R^{14} is alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in the alkyl and the alkenyl, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and in the groups, at least one hydrogen may be replaced by fluorine. X^{12} is $-\text{C}\equiv\text{N}$ or $-\text{C}\equiv\text{C}-\text{C}\equiv\text{N}$.

5

10

15

20

25

30

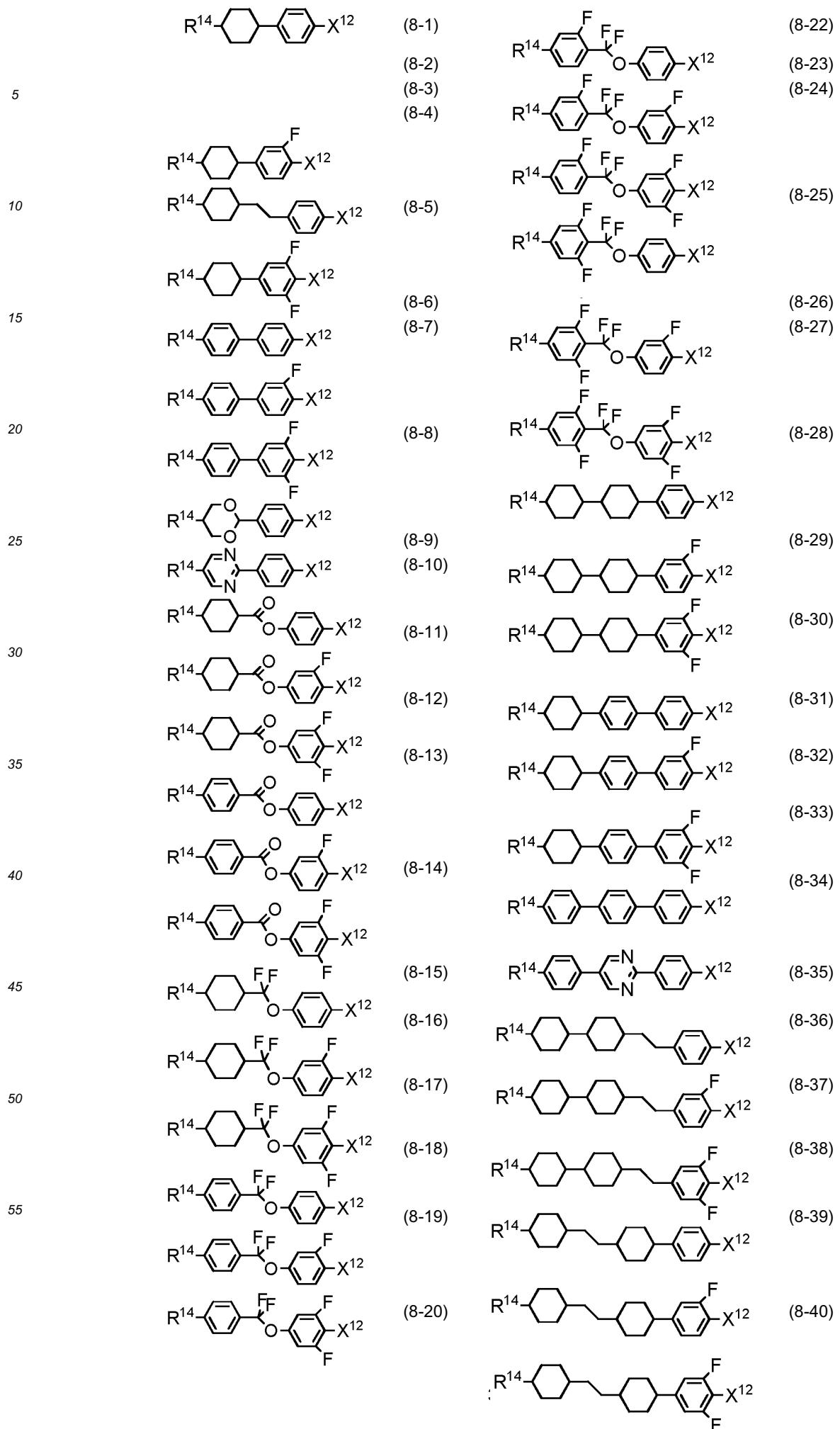
35

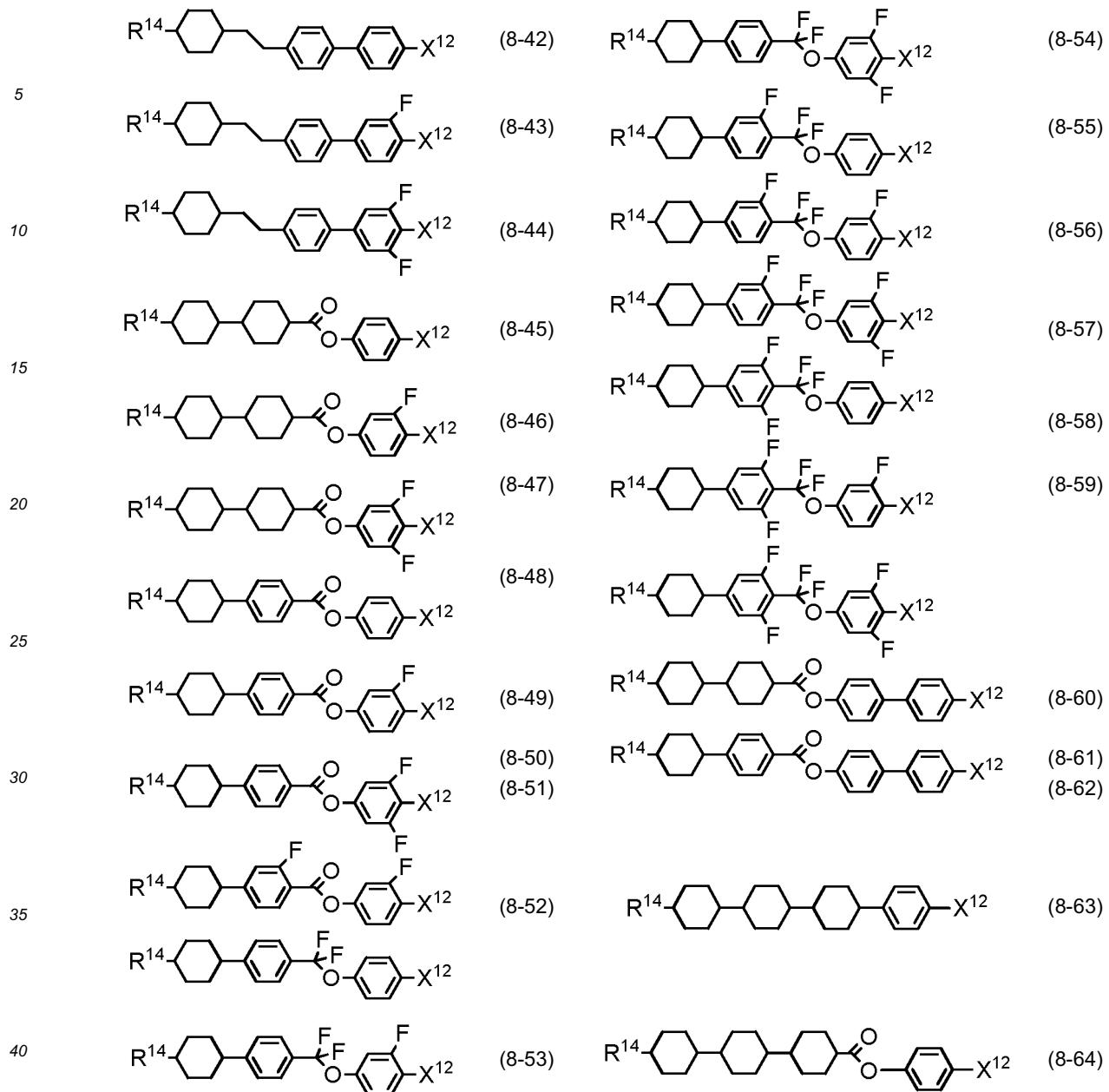
40

45

50

55





[0083] Component D has positive dielectric anisotropy and a value thereof is large, and therefore is used when a composition for the TN mode or the like is prepared. Addition of component D can increase the dielectric anisotropy of the composition. Component D is effective in extending the temperature range of the liquid crystal phase, adjusting the viscosity or adjusting the optical anisotropy. Component D is also useful for adjustment of the voltage-transmittance curve of the device.

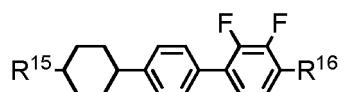
[0084] When the composition for the TN mode or the like is prepared, a proportion of component D is suitably in the range of about 1% by weight to about 99% by weight, preferably in the range of about 10% by weight to about 97% by weight, and further preferably in the range of about 40% by weight to about 95% by weight, based thereon. When component D is added to a composition having negative dielectric anisotropy, the proportion of component D is preferably about 30% by weight or less based thereon. Addition of component D allows adjustment of the elastic constant of the composition and adjustment of the voltage-transmittance curve of the device.

[0085] Component E includes compounds (9) to (15). The compounds have phenylene in which hydrogen in lateral positions are replaced by two halogens, such as 2,3-difluoro-1,4-phenylene. Specific examples of preferred component E include compounds (9-1) to (9-8), compounds (10-1) to (10-17), compound (11-1), compounds (12-1) to (12-3), compounds (13-1) to (13-11), compounds (14-1) to (14-3) and compounds (15-1) to (15-3). In the compounds, R¹⁵, R¹⁶ and

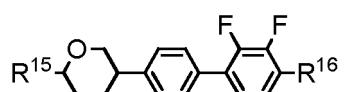
R^{17} are independently alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in the alkyl and the alkenyl, at least one piece of $-CH_2-$ may be replaced by $-O-$, and in the groups, at least one hydrogen may be replaced by fluorine, and R^{17} may be hydrogen or fluorine.

5		(9-1)		(10-13)
10		(9-2)		(10-14)
15		(9-3)		(10-15)
20		(9-4)		(10-16)
25		(9-5)		
30		(9-6)		(10-17)
35		(9-7)		(11-1)
40		(9-8)		
45		(10-1)		(12-1)
50		(10-2)		(12-2)
55		(10-3)		(12-3)
		(10-4)		(13-1)
		(10-5)		(13-2)
		(10-6)		(13-3)

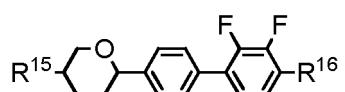
(continued)



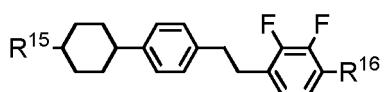
(10-7)



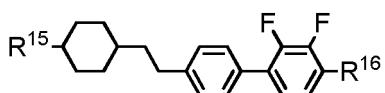
(10-8)



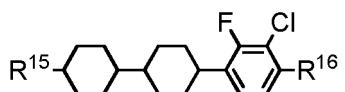
(10-9)



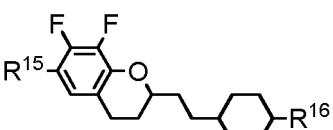
(10-10)



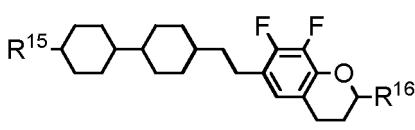
(10-11)



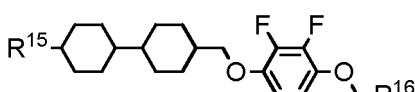
(10-12)



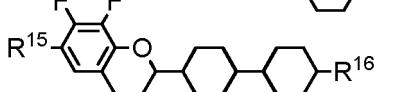
(13-4)



(13-5)



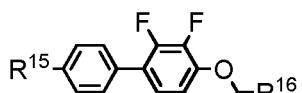
(13-6)



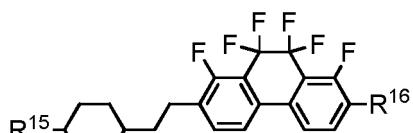
(13-7)



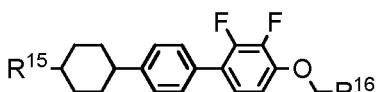
(13-8)



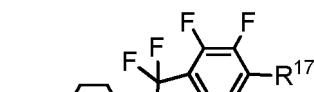
(13-9)



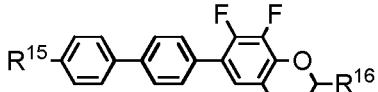
(14-3)



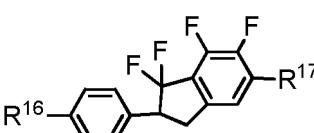
(13-10)



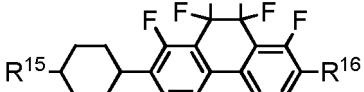
(15-1)



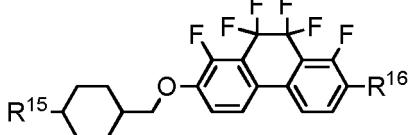
(13-11)



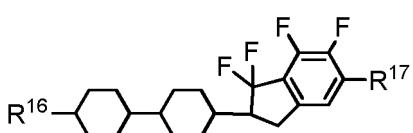
(15-2)



(14-1)



(14-2)



(15-3)

[0086] Component E has large negative dielectric anisotropy. Component E is used when a composition for the IPS mode, the VA mode, the PSA mode or the like is prepared. As a proportion of component E is increased, the dielectric anisotropy of the composition is negatively increased, but the viscosity is increased. Thus, as long as a desired value of threshold voltage of the device is met, the proportion is preferably as small as possible. When the dielectric anisotropy at a degree of -5 is taken into account, a proportion thereof is preferably about 40% by weight or more in order to allow sufficient voltage driving, based thereon.

[0087] Among types of component E, compound (9) is a bicyclic compound, and therefore is effective in decreasing the viscosity, adjusting the optical anisotropy or increasing the dielectric anisotropy. Compounds (10) and (11) are a tricyclic compound, and therefore are effective in increasing the maximum temperature, the optical anisotropy or the dielectric anisotropy. Compounds (12) to (15) are effective in increasing the dielectric anisotropy.

[0088] When a composition for the IPS mode, the VA mode, the PSA mode or the like is prepared, the proportion of component E is preferably about 40% by weight or more, and further preferably in the range of about 50% by weight to about 95% by weight, based thereon. When component E is added to a composition having positive dielectric anisotropy, the proportion of component E is preferably about 30% by weight or less based thereon. Addition of component E allows adjustment of the elastic constant of the composition and adjustment of the voltage-transmittance curve of the device.

[0089] A liquid crystal composition satisfying at least one of physical properties such as high stability to heat or light, high maximum temperature, low minimum temperature, small viscosity, suitable optical anisotropy (more specifically, large optical anisotropy or small optical anisotropy), large dielectric anisotropy, large specific resistance and a suitable elastic constant (more specifically, a large elastic constant or a small elastic constant) can be prepared by suitably combining components B, C, D and E with compound (1). A device including such a composition has a wide temperature range in which the device can be used, a short response time, a large voltage holding ratio, low threshold voltage, a large contrast ratio, a small flicker rate and a long service life.

[0090] If the device is used for a long period of time, a flicker may be occasionally generated on a display screen. The flicker rate (%) can be represented by a formula $(| \text{luminance when applying positive voltage} - \text{luminance when applying negative voltage} |) / (\text{average luminance}) \times 100$. In a device having the flicker rate in the range of about 0% to about 1%, a flicker is hardly generated on the display screen even if the device is used for a long period of time. The flicker is associated with image persistence, and is presumed to be generated according to a difference in electric potential between a positive frame and a negative frame in driving at alternating current. The composition containing compound (1) is also useful for reducing generation of the flicker.

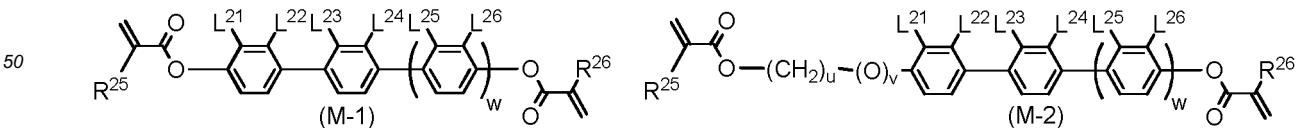
25 3-2. Additive

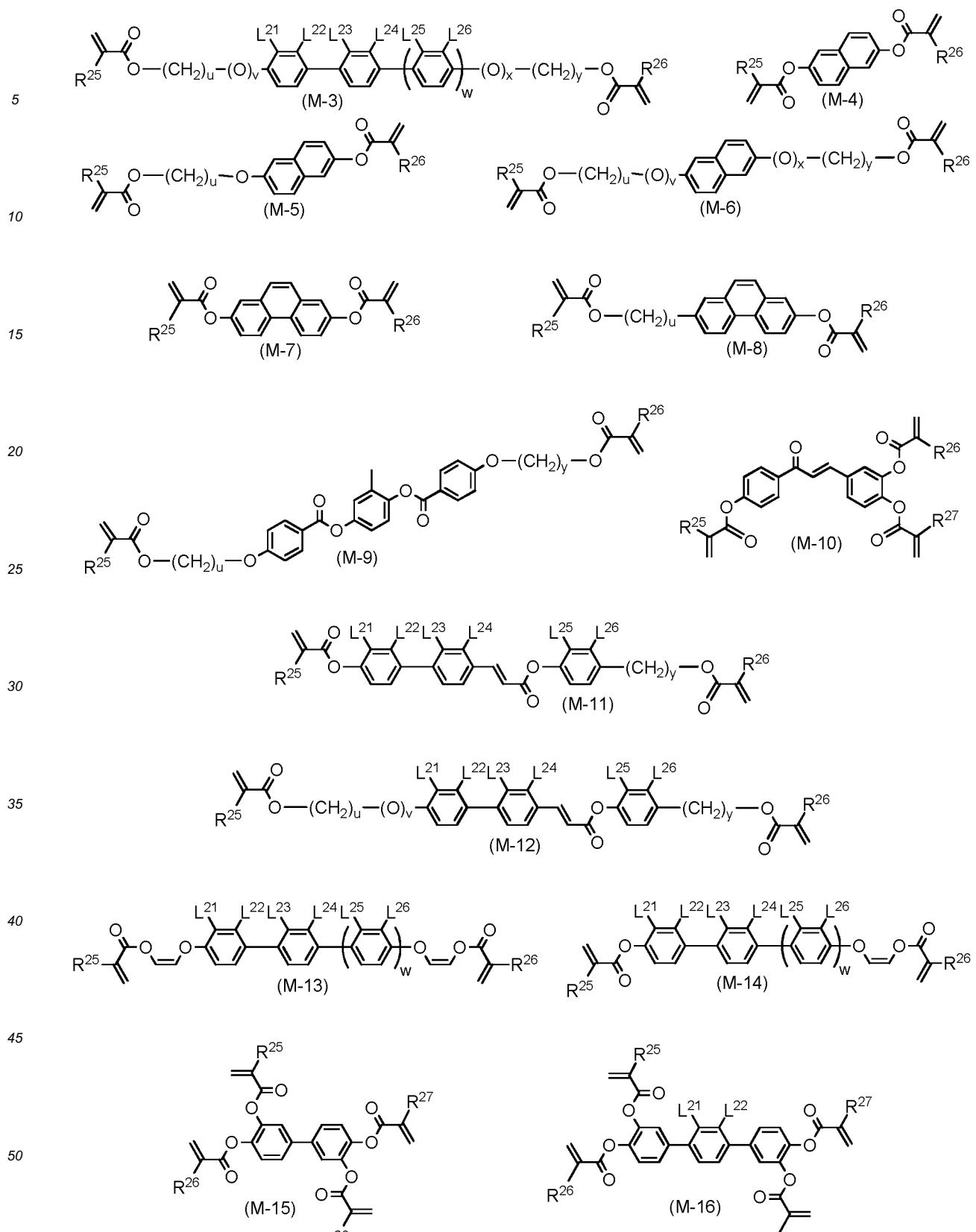
[0091] A liquid crystal composition is prepared according to a publicly known method. For example, the component compounds are mixed and dissolved in each other by heating. According to an application, an additive may be added to the composition. Specific examples of the additive include the polymerizable compound, the polymerization initiator, the polymerization inhibitor, the optically active compound, the antioxidant, the ultraviolet light absorber, the light stabilizer, the heat stabilizer, the dye and the antifoaming agent. Such an additive is well known to those skilled in the art, and described in literature.

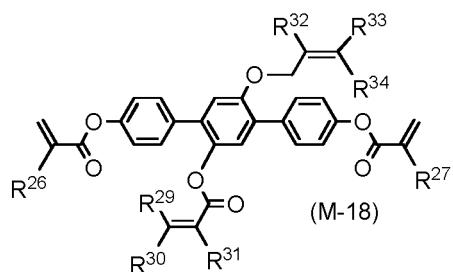
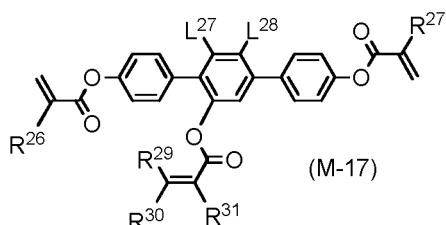
[0092] In a liquid crystal display device having the polymer sustained alignment (PSA) mode, the composition contains a polymer. The polymerizable compound is added for the purpose of forming the polymer in the composition. The polymerizable compound is polymerized by irradiation with ultraviolet light while voltage is applied between electrodes, and thus the polymer is formed in the composition. A suitable pretilt is achieved by the method, and therefore the device in which a response time is shortened and the image persistence is improved is prepared.

[0093] Preferred examples of the polymerizable compound include acrylate, methacrylate, a vinyl compound, a vinyloxy compound, propenyl ether, an epoxy compound (oxirane, oxetane) and vinyl ketone. Further preferred examples include a compound having at least one acryloyloxy, and a compound having at least one methacryloyloxy. Still further preferred examples also include a compound having both acryloyloxy and methacryloyloxy.

[0094] Still further preferred examples include compounds (M-1) to (M-18). In the compounds, R²⁵ to R³¹ are independently hydrogen or methyl; R³², R³³ and R³⁴ are independently hydrogen or alkyl having 1 to 5 carbons, and at least one of R³², R³³ and R³⁴ is alkyl having 1 to 5 carbons; v, w and x are independently 0 or 1; and u and y are independently an integer from 1 to 10. L²¹ to L²⁶ are independently hydrogen or fluorine; and L²⁷ and L²⁸ are independently hydrogen, fluorine or methyl.







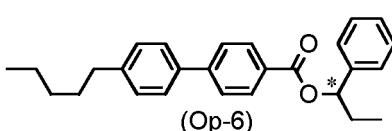
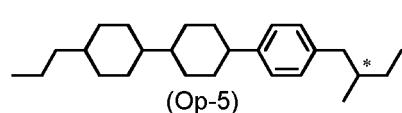
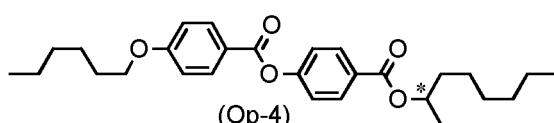
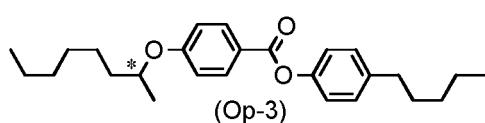
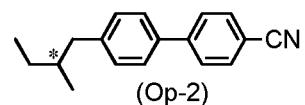
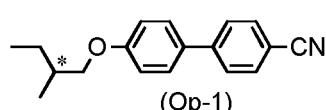
[0095] The polymerizable compound can be rapidly polymerized by adding the polymerization initiator. An amount of a remaining polymerizable compound can be reduced by optimizing reaction conditions. Specific examples of a photoradical polymerization initiator include TPO, 1173 and 4265 from Darocur series of BASF SE, and 184, 369, 500, 651, 784, 819, 907, 1300, 1700, 1800, 1850 and 2959 from Irgacure series thereof.

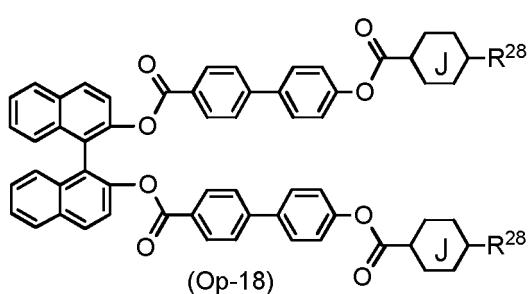
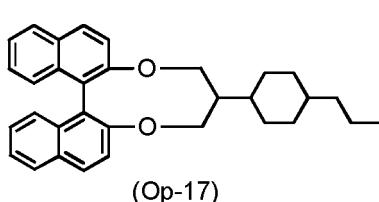
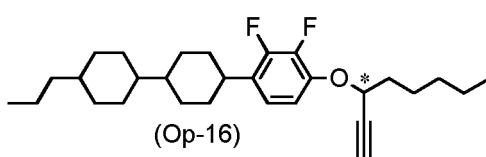
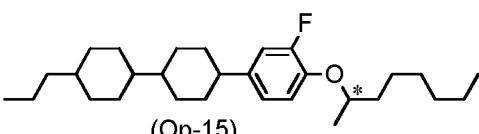
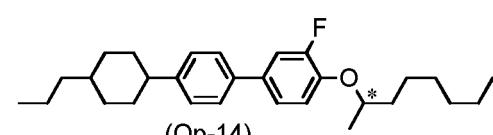
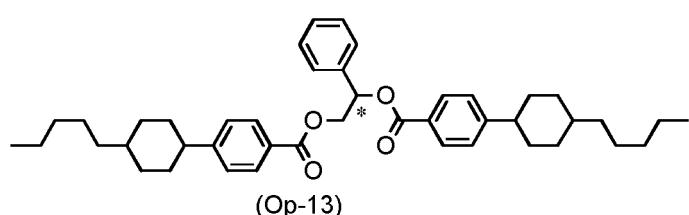
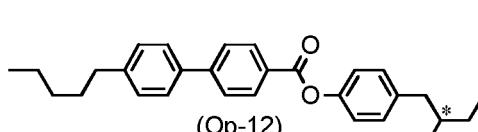
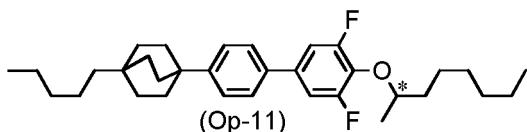
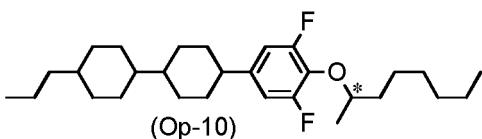
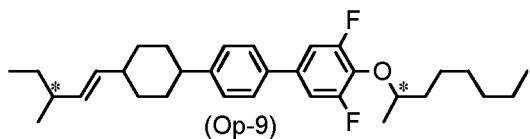
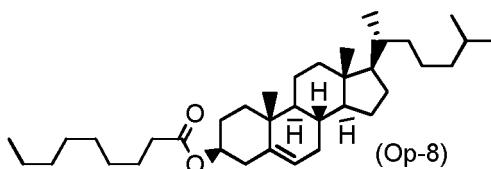
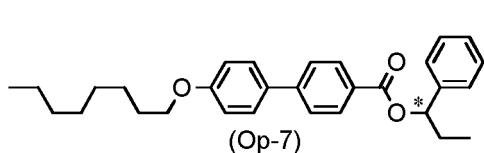
[0096] Additional examples of the photoradical polymerization initiator include 4-methoxyphenyl-2,4-bis(trichloromethyl)triazine, 2-(4-butoxystyryl)-5-trichloromethyl-1,3,4-oxadiazole, 9-phenylacridine, 9,10-benzphenazine, a benzophenone-Michler's ketone mixture, a hexaaryliimidazole-mercaptobenzimidazole mixture, 1-(4-isopropylphenyl)-2-hydroxy-2-methylpropane-1-one, benzyl dimethyl ketal, 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropane-1-one, a mixture of 2,4-diethylxanthone and methyl p-dimethylaminobenzoate, and a mixture of benzophenone and methyltriethanolamine.

[0097] After the photoradical polymerization initiator is added to the liquid crystal composition, polymerization can be performed by irradiation with ultraviolet light while an electric field is applied. However, an unreacted polymerization initiator or a decomposition product of the polymerization initiator may cause poor display such as image persistence in the device. In order to prevent such an event, photopolymerization may be performed with no addition of the polymerization initiator. A preferred wavelength of irradiation light is in the range of about 150 nanometers to about 500 nanometers. A further preferred wavelength is in the range of about 250 nanometers to about 450 nanometers, and a most preferred wavelength is in the range of about 300 nanometers to about 400 nanometers.

[0098] Upon storing the polymerizable compound, the polymerization inhibitor may be added thereto for preventing polymerization. The polymerizable compound is ordinarily added to the composition without removing the polymerization inhibitor. Specific examples of the polymerization inhibitor include hydroquinone, a hydroquinone derivative such as methylhydroquinone, 4-t-butylcatechol, 4-methoxyphenol and phenothiazine.

[0099] The optically active compound is effective in inducing helical structure in liquid crystal molecules to give a required twist angle, and thereby preventing a reverse twist. A helical pitch can be adjusted by adding the optically active compound thereto. Two or more optically active compounds may be added for the purpose of adjusting temperature dependence of the helical pitch. Specific examples of a preferred optically active compound include compounds (Op-1) to (Op-18) described below. In compound (Op-18), ring J is 1, 4-cyclohexylene or 1, 4-phenylene, and R²⁸ is alkyl having 1 to 10 carbons. Asterisk mark (*) represents asymmetrical carbon.

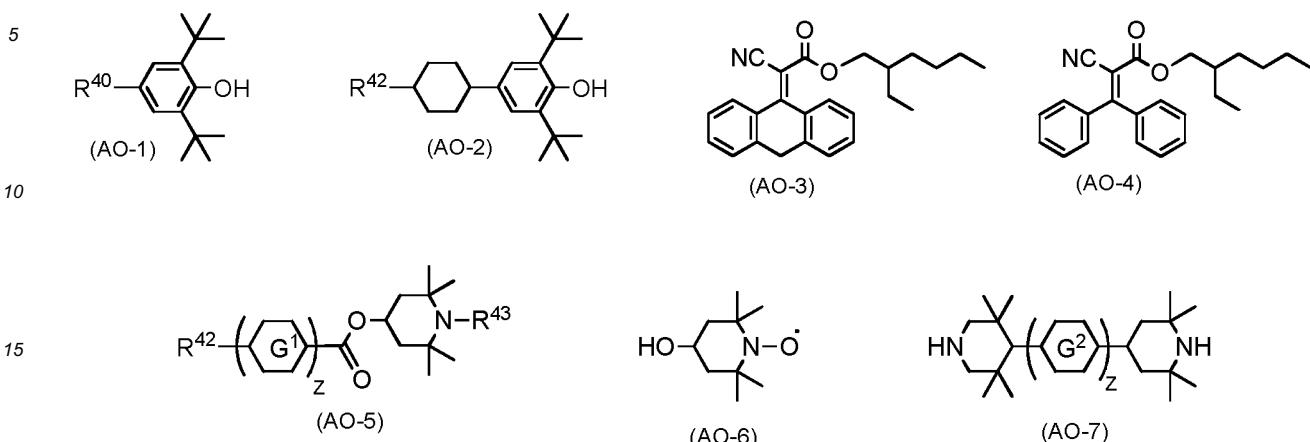




45 [0100] The antioxidant is effective for maintaining the large voltage holding ratio. Specific examples of a preferred antioxidant include compounds (AO-1) and (AO-2) described below; and Irganox 415, Irganox 565, Irganox 1010, Irganox 1035, Irganox 3114 and Irganox 1098 (trade names; BASF SE). The ultraviolet light absorber is effective for preventing a decrease of the maximum temperature. Preferred examples of the ultraviolet light absorbers include a benzophenone derivative, a benzoate derivative and a triazole derivative, and specific examples include compounds (AO-3) and (AO-4) described below; Tinuvin 329, Tinuvin P, Tinuvin 326, Tinuvin 234, Tinuvin 213, Tinuvin 400, Tinuvin 328 and Tinuvin 99-2 (trade names; BASF SE); and 1,4-diazabicyclo[2.2.2]octane (DABCO).

50 [0101] The light stabilizer such as an amine having steric hindrance is preferred for maintaining the large voltage holding ratio. Specific examples of a preferred light stabilizer include compounds (AO-5), (AO-6) and (AO-7) described below; Tinuvin 144, Tinuvin 765 and Tinuvin 770DF (trade names; BASF SE); and LA-77Y and LA-77G (trade names; ADEKA Corporation). The heat stabilizer is also effective for maintaining the large voltage holding ratio, and specific preferred examples include Irgafos 168 (trade name; BASF SE). A dichroic dye such as an azo dye or an anthraquinone dye is added to the composition to be adapted for a device having a guest host (GH) mode. The antifoaming agent is

effective for preventing foam formation. Specific examples of a preferred antifoaming agent include dimethyl silicone oil and methylphenyl silicone oil.



20 [0102] In compound (AO-1), R⁴⁰ is alkyl having 1 to 20 carbons, alkoxy having 1 to 20 carbons, -COOR⁴¹ or -CH₂CH₂COOR⁴¹, in which R⁴¹ is alkyl having 1 to 20 carbons. In compounds (AO-2) and (AO-5), R⁴² is alkyl having 1 to 20 carbons. In compound (AO-5), R⁴³ is hydrogen, methyl or O[·] (oxygen radical); and ring G¹ is 1, 4-cyclohexylene or 1, 4-phenylene; and in compound (AO-7), ring G² is 1, 4-cyclohexylene, 1, 4-phenylene or 1, 4-phenylene in which at least one hydrogen is replaced by fluorine; and in compounds (AO-5) and (AO-7), z is 1, 2 or 3.

25 4. Liquid crystal display device

30 [0103] The liquid crystal composition can be used in a liquid crystal display device having an operating mode such as the PC mode, the TN mode, the STN mode, the OCB mode and the PSA mode, and driven by an active matrix mode. The composition can also be used in a liquid crystal display device having the operating mode such as the PC mode, the TN mode, the STN mode, the OCB mode, the VA mode and the IPS mode, and driven by a passive matrix mode. The devices can be applied to any of a reflective type, a transmissive type and a transflective type.

35 [0104] The composition is also suitable for a nematic curvilinear aligned phase (NCAP) device, and the composition is microencapsulated herein. The composition can also be used in a polymer-dispersed liquid crystal display device (PDLCD), a polymer-networked liquid crystal display device (PNLCD) and a nanocapsule-dispersed liquid crystal display device. In the compositions, a large amount of polymerizable compound is added. On the other hand, when a proportion of the polymerizable compound is about 10% by weight or less based on the weight of the liquid crystal composition, the liquid crystal display device having the PSA mode can be prepared. A preferred proportion is in the range of about 0.1% by weight to about 2% by weight based thereon. A further preferred proportion is in the range of about 0.2% by weight to about 1.0% by weight based thereon. The device having the PSA mode can be driven by the driving mode such as the active matrix mode and the passive matrix mode. Such devices can be applied to any of the reflective type, the transmissive type and the transflective type.

40 [0105] The liquid crystal composition is suitable also for a liquid crystal display device having a capability of stereoscopic display. In a liquid crystal lens mode, a gradient refractive index lens is combined with an ordinary liquid crystal display device. When the composition is put in the lens and voltage is applied thereto, a distribution is caused in a refractive index in the composition. Thus, a lens effect is developed, and an image is displayed in three dimensions (3D). When no voltage is applied thereto, the image is displayed in two dimensions (2D). Accordingly, switching between 2D and 3D can be performed by electrically turning on or turning off the gradient refractive index lens.

50 Examples

1. Example of compound (1)

55 [0106] The invention will be described in greater detail by way of Examples. The Examples include a typical example, and therefore the invention is not limited by the Examples. The invention includes a mixture of a composition in Use Example 1 and a composition in Use Example 2. The invention also includes a mixture in which at least two compositions in Use Examples are mixed. Compound (1) was prepared according to procedures described below. The thus prepared compound was identified by methods such as an NMR analysis. Physical properties of the compound and the composition,

and characteristics of a device were measured by methods described below.

[0107] NMR analysis: For measurement, DRX-500 made by Bruker BioSpin Corporation was used. In ^1H -NMR measurement, a sample was dissolved in a deuterated solvent such as CDCl_3 , and measurement was carried out under conditions of room temperature, 500 MHz and 16 times of accumulation. Tetramethylsilane was used as an internal standard. In ^{19}F -NMR measurement, CFCI_3 was used as an internal standard, and measurement was carried out under conditions of 24 times of accumulation. In explaining nuclear magnetic resonance spectra obtained, s, d, t, q, quin, sex and m stand for a singlet, a doublet, a triplet, a quartet, a quintet, a sextet and a multiplet, and br being broad, respectively.

[0108] Mass analysis: For measurement, QP-2010 Ultra Gas Chromatograph Mass Spectrometer made by Shimadzu Corporation was used. As a column, a capillary column DB-1 (length 60 m, bore 0.25 mm, film thickness 0.25 μm) made by Agilent Technologies, Inc. was used. As a carrier gas, helium (1 mL/minute) was used. A temperature of a sample vaporizing chamber, a temperature of an ion source, ionizing voltage and emission current were set to 300°C, 200°C, 70 eV and 150 uA, respectively. A sample was dissolved in acetone and prepared to be a 1 weight % solution, and then 1 microliter of the solution obtained was injected into the sample vaporizing chamber. As a recorder, GCMS Solution System made by Shimadzu Corporation was used.

[0109] Gas chromatographic analysis: For measurement, GC-2010 Gas Chromatograph made by Shimadzu Corporation was used. As a column, a capillary column DB-1 (length 60 m, bore 0.25 mm, film thickness 0.25 μm) made by Agilent Technologies, Inc. was used. As a carrier gas, helium (1 mL/minute) was used. A temperature of a sample vaporizing chamber and a temperature of a detector (FID) were set to 300°C and 300°C, respectively. A sample was dissolved in acetone and prepared to be a 1 weight % solution, and then 1 microliter of the solution obtained was injected into the sample vaporizing chamber. As a recorder, GC Solution System made by Shimadzu Corporation or the like was used.

[0110] HPLC analysis: For measurement, Prominence (LC-20AD; SPD-20A) made by Shimadzu Corporation was used. As a column, YMC-Pack ODS-A (length 150 mm, bore 4.6 mm, particle diameter 5 μm) made by YMC Co., Ltd. was used. As an eluate, acetonitrile and water were appropriately mixed and used. As a detector, a UV detector, an RI detector, a CORONA detector or the like was appropriately used. When the UV detector was used, a detection wavelength was set to 254 nanometers. A sample was dissolved in acetonitrile and prepared to be a 0.1 weight % solution, and then 1 microliter of the solution was injected into a sample chamber. As a recorder, C-R7Aplus made by Shimadzu Corporation was used.

[0111] Ultraviolet-Visible spectrophotometry: For measurement, PharmaSpec UV-1700 made by Shimadzu Corporation was used. A detection wavelength was adjusted in the range of 190 nanometers to 700 nanometers. A sample was dissolved in acetonitrile and prepared to be a 0.01 mmol/L solution, and measurement was carried out by putting the solution in a quartz cell (optical path length: 1 cm).

[0112] Sample for measurement: Upon measuring phase structure and a transition temperature (a clearing point, a melting point, a polymerization starting temperature or the like), the compound itself was used as a sample. Upon measuring physical properties such as maximum temperature of a nematic phase, viscosity, optical anisotropy and dielectric anisotropy, a mixture of the compound and a base liquid crystal was used as a sample.

[0113] Extrapolation method: When the sample prepared by mixing the compound with the base liquid crystal was used, an extrapolated value was calculated according to the following equation and the calculated value was described: $[\text{extrapolated value}] = (100 \times [\text{measured value of a sample}] - [\% \text{ by weight of a base liquid crystal}] \times [\text{measured value of the base liquid crystal}]) / [\% \text{ by weight of a compound}]$.

[0114] Base liquid crystal (A): When the dielectric anisotropy of the compound was zero or positive, base liquid crystal (A) described below was used. A proportion of each component was expressed in terms of weight percent (% by weight).

45	$\text{C}_3\text{H}_7-\text{C}_6\text{H}_4-\text{C}_6\text{H}_4-\text{CN}$	24%
	$\text{C}_5\text{H}_{11}-\text{C}_6\text{H}_4-\text{C}_6\text{H}_4-\text{CN}$	36%
50	$\text{C}_7\text{H}_{15}-\text{C}_6\text{H}_4-\text{C}_6\text{H}_4-\text{CN}$	25%
	$\text{C}_5\text{H}_{11}-\text{C}_6\text{H}_4-\text{C}_6\text{H}_4-\text{C}_6\text{H}_4-\text{CN}$	15%

[0115] A ratio of the compound to base liquid crystal (A) was adjusted to (15% by weight : 85% by weight). When crystals (or a smectic phase) precipitated at 25°C at the ratio, a ratio of the compound to base liquid crystal (A) was changed in the order of (10% by weight : 90% by weight), (5% by weight : 95% by weight) and (1% by weight : 99% by

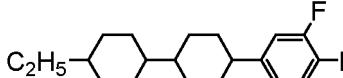
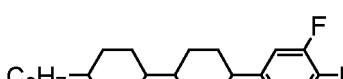
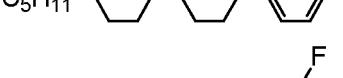
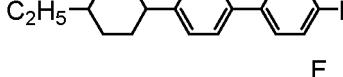
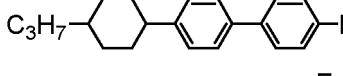
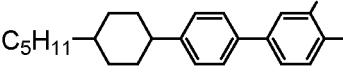
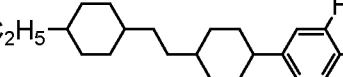
weight), and the sample was measured at a ratio at which no crystal (or no smectic phase) precipitated at 25°C. In addition, unless otherwise noted, the ratio of the compound to base liquid crystal (A) was (15% by weight : 85% by weight). **[0116]** Base liquid crystal (B): When the dielectric anisotropy of the compound was zero or negative, base liquid crystal (B) described below was used. A proportion of each component was expressed in terms of weight percent (% by weight).

5

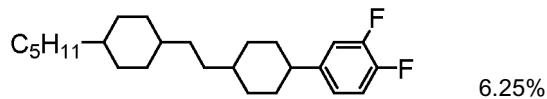
10	<chem>C3H7C1CCCC1C(=O)c2ccc(OCC2)cc2</chem>	17.2%
	<chem>C3H7C1CCCC1C(=O)c2ccc(OCC4)cc4</chem>	27.6%
15	<chem>C4H9C1CCCC1C(=O)c2ccc(OCC2)cc2</chem>	20.7%
	<chem>C5H11C1CCCC1C(=O)c2ccc(OCH3)cc2</chem>	20.7%
	<chem>C5H11C1CCCC1C(=O)c2ccc(OCC2)cc2</chem>	13.8%

[0117] A ratio of the compound to base liquid crystal (B) was adjusted to (20% by weight : 80% by weight). When crystals (or a smectic phase) precipitated at 25°C at the ratio, a ratio of the compound to base liquid crystal (B) was changed in the order of (15% by weight : 85% by weight), (10% by weight : 90% by weight), (5% by weight : 95% by weight) and (1% by weight : 99% by weight), and physical properties of the sample were measured at a ratio at which no crystal (or no smectic phase) precipitated at 25°C. In addition, unless otherwise noted, the ratio of the compound to base liquid crystal (B) was (20% by weight : 80% by weight).

[0118] Base liquid crystal (C) : Base liquid crystal (B) containing a fluorine type compound described below as a component was occasionally used. A proportion of each component was expressed in terms of weight percent (% by weight).

30		16.67%
35		16.67%
40		16.67%
45		6.25%
50		6.25%
55		12.49%
		12.50%
		6.25%

(continued)



10 [0119] Measuring method: Physical properties were measured according to methods described below. Most of the methods are described in the Standard of Japan Electronics and Information Technology Industries Association (JEITA) discussed and established in JEITA (JEITA ED-2521B). A modified method was also applied. No thin film transistor (TFT) was attached to a TN device used for measurement.

15 (1) Phase structure: A sample was placed on a hot plate in a melting point apparatus (FP-52 Hot Stage made by Mettler-Toledo International Inc.) equipped with a polarizing microscope. A state of phase and a change thereof were observed with the polarizing microscope while the sample was heated at a rate of 3°C per minute, and a kind of the phase was specified.

20 (2) Transition temperature (°C): For measurement, a differential scanning calorimeter, Diamond DSC System, made by PerkinElmer, Inc., or a high sensitivity differential scanning calorimeter, X-DSC7000, made by SII NanoTechnology Inc. was used. A sample was heated and then cooled at a rate of 3°C per minute, and a starting point of an endothermic peak or an exothermic peak caused by a phase change of the sample was determined by extrapolation, and thus a transition temperature was determined. A melting point and a polymerization starting temperature of a compound were also measured using the apparatus. Temperature at which a compound undergoes transition from a solid to a liquid crystal phase such as the smectic phase and the nematic phase may be occasionally abbreviated as "minimum temperature of the liquid crystal phase." Temperature at which the compound undergoes transition from the liquid crystal phase to liquid may be occasionally abbreviated as "clearing point."

25 A crystal was expressed as C. When the crystals were distinguishable into two kinds, each of the crystals was expressed as C₁ or C₂. The smectic phase or the nematic phase was expressed as S or N. When a phase such as smectic A phase, smectic B phase, smectic C phase and smectic F phase was distinguishable, the phase was expressed as S_A, S_B, S_C and S_F, respectively. A liquid (isotropic) was expressed as I. A transition temperature was expressed as "C 50.0 N 100.0 I," for example. The expression indicates that a transition temperature from the crystals to the nematic phase is 50.0°C, and a transition temperature from the nematic phase to the liquid is 100.0°C.

30 (3) Compatibility of compound: Samples in which the base liquid crystal and the compound were mixed for proportions of the compounds to be 20% by weight, 15% by weight, 10% by weight, 5% by weight, 3% by weight or 1% by weight were prepared. The samples were put in glass vials, and kept in freezers at -20°C or -30°C for a predetermined period of time. Whether a nematic phase of the samples was maintained or crystals (or a smectic phase) precipitated was observed. Conditions on which the nematic phase was maintained were used as a measure of the compatibility. Proportions of the compounds and each temperature in the freezers may be occasionally changed when necessary.

35 (4) Maximum temperature of nematic phase (T_{NI} or NI; °C): A sample was placed on a hot plate in a melting point apparatus equipped with a polarizing microscope, and heated at a rate of 1°C per minute. Temperature when part of the sample began to change from a nematic phase to an isotropic liquid was measured. When the sample was a mixture of compound (1) and the base liquid crystal, the maximum temperature was expressed in terms of a symbol T_{NI}. The value was calculated from the measured value by using the extrapolation method described above. When the sample was a mixture of compound (1) and a compound selected from compounds (2) to (15), the measured value was expressed in terms of a symbol NI. A maximum temperature of the nematic phase may be occasionally abbreviated as "maximum temperature."

40 (5) Minimum temperature of nematic phase (T_C; °C): Samples each having a nematic phase were put in glass vials and kept in freezers at temperatures of 0°C, -10°C, -20°C, -30°C and -40°C for 10 days, and then liquid crystal phases were observed. For example, when the sample was maintained in the nematic phase at -20°C and changed to crystals or a smectic phase at -30°C, T_C was expressed as T_C < -20°C. A minimum temperature of the nematic phase may be occasionally abbreviated as "minimum temperature."

45 (6) Viscosity (bulk viscosity; η ; measured at 20°C; mPa·s) : For measurement, a cone-plate (E type) rotational viscometer made by Tokyo Keiki Inc. was used.

50 (7) Viscosity (rotational viscosity; γ_1 ; measured at 25°C; mPa·s): Measurement was carried out according to a method described in M. Imai et al., Molecular Crystals and Liquid Crystals, Vol. 259, p. 37 (1995) . A sample was put in a TN device in which a twist angle was 0 degrees and a distance (cell gap) between two glass substrates was 5 micrometers. Voltage was applied stepwise to the device from 16 V to 19.5 V at an increment of 0.5 V. After a period of 0.2 second with no voltage application, voltage was repeatedly applied under conditions of only one rectangular wave (rectangular pulse; 0.2 second) and no voltage application (2 seconds). A peak current and a peak

time of transient current generated by the applied voltage were measured. A value of rotational viscosity was obtained from the measured values and equation (8) on page 40 of the paper presented by M. Imai et al. A value of dielectric anisotropy required for the calculation was determined using the device by which the rotational viscosity was measured and by a method described below.

(8) Optical anisotropy (refractive index anisotropy; measured at 25°C; Δn): Measurement was carried out by an Abbe refractometer with a polarizing plate mounted on an ocular, using light at a wavelength of 589 nanometers. A surface of a main prism was rubbed in one direction, and then a sample was added dropwise onto the main prism. A refractive index ($n_{||}$) was measured when a direction of polarized light was parallel to a direction of rubbing. A refractive index (n_{\perp}) was measured when the direction of polarized light was perpendicular to the direction of rubbing.

A value of optical anisotropy (Δn) was calculated from an equation: $\Delta n = n_{||} - n_{\perp}$.

(9) Dielectric anisotropy ($\Delta \epsilon$; measured at 25°C): A sample was put in a TN device in which a distance (cell gap) between two glass substrates was 9 micrometers and a twist angle was 80 degrees. Sine waves (10 V, 1 kHz) were applied to the device, and after 2 seconds, a dielectric constant ($\epsilon_{||}$) of liquid crystal molecules in a major axis direction was measured. Sine waves (0.5 V, 1 kHz) were applied to the device, and after 2 seconds, a dielectric constant (ϵ_{\perp}) of liquid crystal molecules in a minor axis direction was measured. A value of dielectric anisotropy was calculated from an equation: $\Delta \epsilon = \epsilon_{||} - \epsilon_{\perp}$.

(10) Elastic constant (K; measured at 25°C; pN): For measurement, HP4284A LCR Meter made by Yokogawa-Hewlett-Packard Co. was used. A sample was put in a horizontal alignment device in which a distance (cell gap) between two glass substrates was 20 micrometers. An electric charge from 0 V to 20 V was applied to the device, and electrostatic capacity (C) and applied voltage (V) were measured. The measured values were fitted to equation (2.98) and equation (2.101) on page 75 of "Liquid Crystal Device Handbook (Ekisho Debaisu Handobukku in Japanese; Nikkan Kogyo Shimbun, Ltd.)," and values of K_{11} and K_{33} were obtained from equation (2.99). Next, K_{22} was calculated using the previously determined values of K_{11} and K_{33} in equation (3.18) on page 171. Elastic constant K was expressed in terms of a mean value of the thus determined K_{11} , K_{22} and K_{33} .

(11) Threshold voltage (V_{th} ; measured at 25°C; V): For measurement, an LCD-5100 luminance meter made by Otsuka Electronics Co., Ltd. was used. A light source was a halogen lamp. A sample was put in a normally white mode TN device in which a distance (cell gap) between two glass substrates was $0.45/\Delta n$ (μm) and a twist angle was 80 degrees. A voltage (32 Hz, rectangular waves) to be applied to the device was stepwise increased from 0 V to 10 V at an increment of 0.02 V. On the occasion, the device was irradiated with light from a direction perpendicular to the device, and an amount of light transmitted through the device was measured. A voltage-transmittance curve was prepared, in which the maximum amount of light corresponds to 100% transmittance and the minimum amount of light corresponds to 0% transmittance. A threshold voltage is expressed in terms of voltage at 90% transmittance.

(12) Voltage holding ratio (VHR-1; measured at 25°C; %): A TN device used for measurement had a polyimide alignment film, and a distance (cell gap) between two glass substrates was 5 micrometers. A sample was put in the device, and then the device was sealed with an ultraviolet-curable adhesive. The device was charged by applying a pulse voltage (60 microseconds at 5 V) at 25°C. A decaying voltage was measured for 16.7 milliseconds with a high-speed voltmeter, and area A between a voltage curve and a horizontal axis in a unit cycle was determined. Area B is an area without decay. A voltage holding ratio is expressed in terms of a percentage of area A to area B.

(13) Voltage holding ratio (VHR-2; measured at 80°C; %): A voltage holding ratio was measured according to a method described above except that the voltage holding ratio was measured at 80°C in place of 25°C. The results obtained were expressed in terms of a symbol VHR-2.

(14) Specific resistance (ρ ; measured at 25°C; Qcm): Into a vessel equipped with electrodes, 1.0 milliliter of sample was injected. A direct current voltage (10 V) was applied to the vessel, and a direct current after 10 seconds was measured. Specific resistance was calculated from the following equation:

$$(\text{specific resistance}) = \{ (\text{voltage}) \times (\text{electric capacity of a vessel}) \} / \{ (\text{direct current}) \times (\text{dielectric constant of vacuum}) \}.$$

(15) Response time (τ ; measured at 25°C; ms) : For measurement, an LCD-5100 luminance meter made by Otsuka Electronics Co., Ltd. was used. A light source was a halogen lamp. A low-pass filter was set to 5 kHz. A sample was put in a normally white mode TN device in which a distance (cell gap) between two glass substrates was 5.0 micrometers and a twist angle was 80 degrees. A voltage (rectangular waves; 60 Hz, 5 V, 0.5 second) was applied to the device. On the occasion, the device was irradiated with light from a direction perpendicular to the device, and an amount of light transmitted through the device was measured. The maximum amount of light corresponds to 100% transmittance, and the minimum amount of light corresponds to 0% transmittance. Arise time (τ_r ; millisecond) was expressed in terms of time required for a change from 90% transmittance to 10% transmittance. A fall time (τ_f ; millisecond) was expressed in terms of time required for a change from 10% transmittance to 90% transmittance.

A response time was expressed by a sum of the rise time and the fall time thus determined.

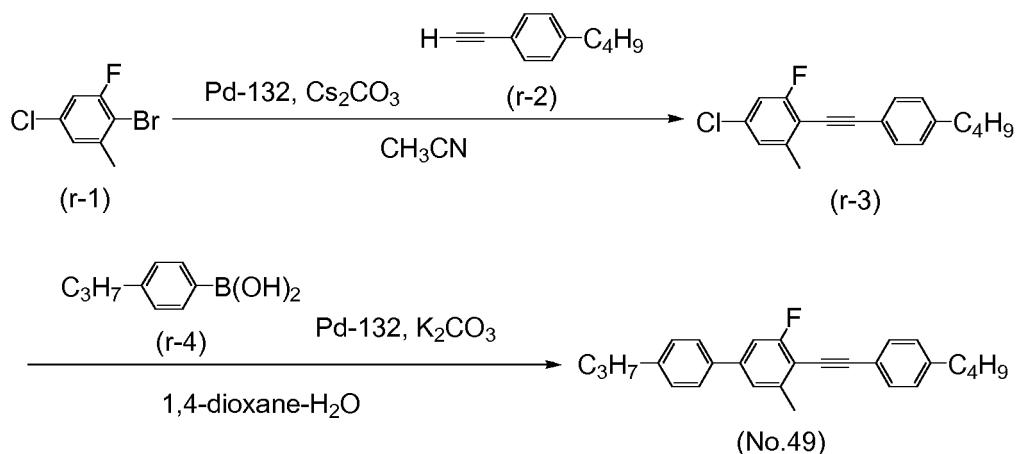
(16) Flicker rate (measured at 25°C; %): For measurement, 3298F Multimedia Display Tester made by Yokogawa Electric Corporation was used. A light source was LED. A sample was put in a normally black mode FFS device in which a distance (cell gap) between two glass substrates was 3.5 micrometers and a rubbing direction was anti-parallel. The device was sealed with an ultraviolet-curable adhesive. Voltage was applied to the device, and a voltage having a maximum amount of light transmitted through the device was measured. A flicker rate displayed thereon was read by bringing a sensor unit close to the device while voltage was applied to the device.

[0120] Raw material: Solmix (registered trademark) A-11 is a mixture of ethanol (85.5%), methanol (13.4%) and isopropanol (1.1%), and was purchased from Japan Alcohol Trading Co., Ltd.

Synthesis Example 1

Synthesis of compound (No. 49)

[0121]



First step

[0122] In a reaction vessel, 0.079 g (0.11 mmol) of dichlorobis[di-*t*-butyl(*p*-dimethylaminophenyl)phosphino]palladium (II) (abbreviated as Pd-132) and 14.6 g of cesium carbonate were put, and then the reaction vessel was decompressed, and argon was introduced thereinto. The operation was repeated 3 times. Compound (r-1) (5.0 g, 22.4 mmol) dissolved in 50 mL of acetonitrile and compound (r-2) (3.54 g, 22.4 mmol) dissolved in 50 mL of acetonitrile were added thereto, and the resulting mixture was stirred and heated at 80°C for 4 hours. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane) to obtain 4.4 g of compound (r-3).

Second step

[0123] In a reaction vessel, compound (r-3) (3.4 g, 11.3 mmol) dissolved in 60mL of 1,4-dioxane was put, and 0.08 g (0.11 mmol) of Pd-132, 3.1 g (22.6 mmol) of potassium carbonate and 8 mL of a distilled water were added thereinto. Compound (r-4) (2.78 g, 17.0 mmol) dissolved in 20 mL of 1,4-dioxane was added thereto, and the resulting mixture was stirred and heated under reflux for 4 hours under a nitrogen atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane), and further recrystallized from a mixed solvent (heptane/Solmix A-11 = 1/4 in a volume ratio) to obtain 3.20 g of compound (No. 49).

[0124] ¹H-NMR(δ ppm; CDCl₃) : 7.49 (d, 2H), 7.47 (d, 2H), 7.24 (d, 2H), 7.22 (d, 1H), 7.17 - 7.15 (m, 3H), 2.62 (t, 4H), 2.55 (s, 3H), 1.67 (sex, 2H), 1.60 (quin, 2H), 1.35 (sex, 2H), 0.96 (t, 3H), 0.93 (t, 3H).

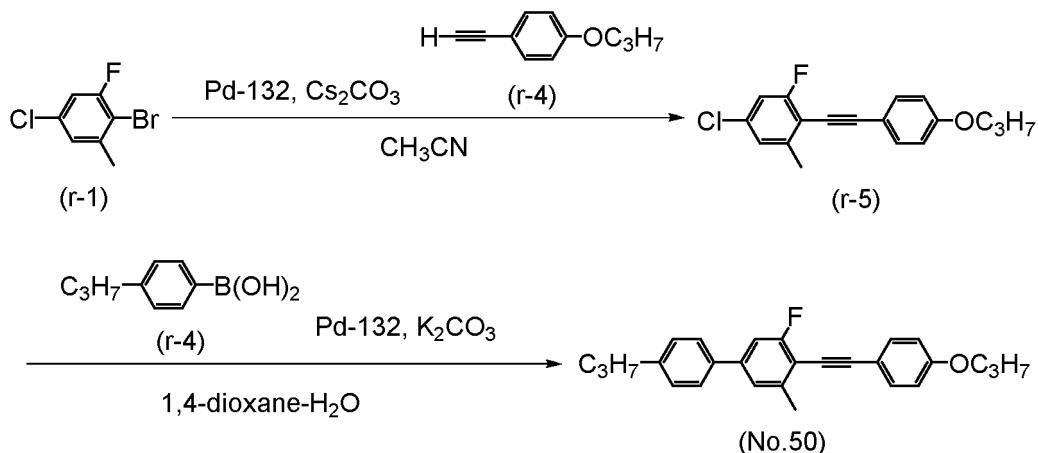
[0125] For measurement of the transition temperature, compound (No. 49) was used as a sample as was. For measurement of the maximum temperature (T_{NI}), the dielectric anisotropy ($\Delta\epsilon$) and the optical anisotropy (Δn), a mixture of compound (No. 49) and base liquid crystal (A) was used as a sample. The measurement method was applied also to a compound prepared as described below.

[0126] Transition temperature: C 77.1 N 133.1 I. $T_{NI} = 116.4^{\circ}\text{C}$, $\Delta\epsilon = 6.1$, $\Delta n = 0.310$.

Synthesis Example 2

Synthesis of compound (No. 50)

[0127]



First step

[0128] In a reaction vessel, 0.079 g (0.11 mmol) of Pd-132 and 14.6 g of cesium carbonate were put, and then the reaction vessel was decompressed, and argon was introduced thereinto. The operation was repeated 3 times. Compound (r-1) (5.0 g, 22.4 mmol) dissolved in 50 mL of acetonitrile and compound (r-4) (3.58 g, 22.4 mmol) dissolved in 50 mL of acetonitrile were added thereto, and the resulting mixture was stirred and heated at 80°C for 4 hours under an argon atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane) to obtain 3.63 g of compound (r-5).

Second step

[0129] In a reaction vessel, compound (r-5) (3.6 g, 11.3 mmol) dissolved in 60 mL of 1,4-dioxane was put, and 0.084 g (0.12 mmol) of Pd-132, 3.31 g (24.0 mmol) of potassium carbonate and 8 mL of distilled water were added thereinto, and compound (r-4) (2.95 g, 18.0 mmol) dissolved in 20 mL of 1,4-dioxane was added thereto, and the resulting mixture was stirred and heated under reflux for 4 hours under a nitrogen atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane/toluene = 1/4 in a volume ratio), and further recrystallized from a mixed solvent (heptane/Solmix A-11 = 1/5 in a volume ratio) to obtain 2.74 g of compound (No. 50).

[0130] $^1\text{H-NMR}$ (δ ppm; CDCl_3): 7.49 (d, 2H), 7.48 (d, 2H), 7.23 (d, 3H), 7.15 (d, 1H), 6.87 (d, 2H), 3.92 (t, 2H), 2.61 (t, 2H), 2.55 (s, 3H), 1.67 (sex, 2H), 1.60 (quin, 2H), 1.35 (sex, 2H), 0.96 (t, 3H), 0.93 (t, 3H).

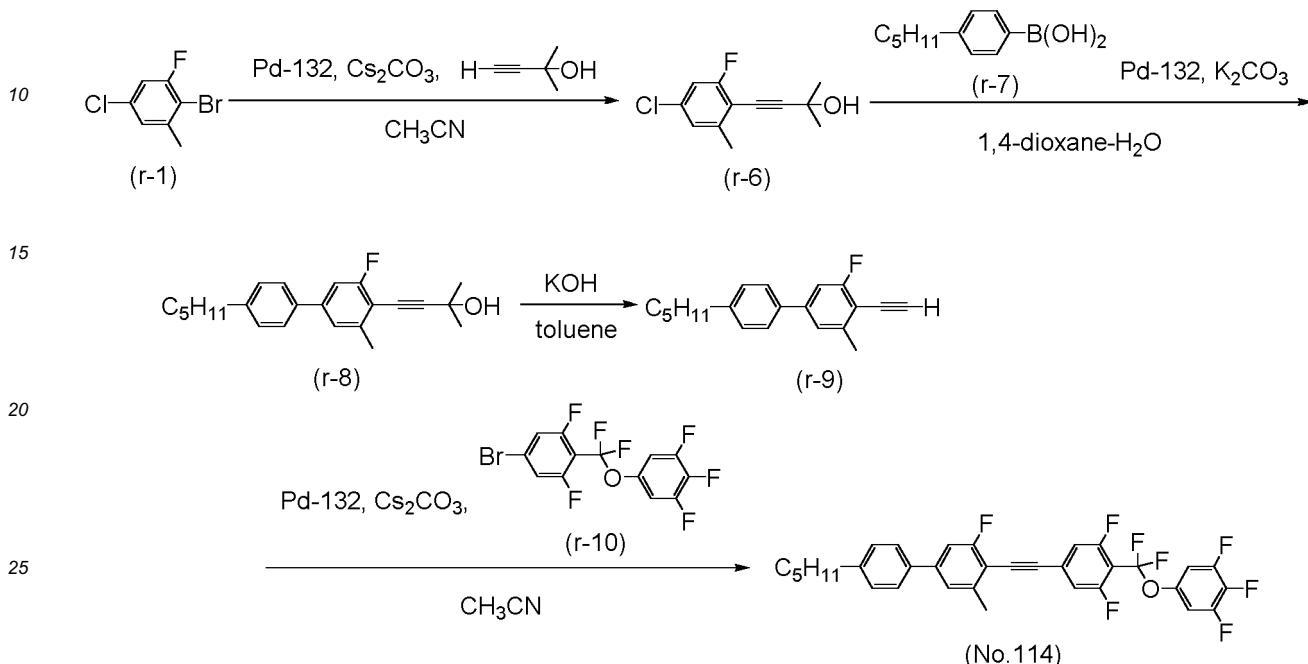
[0131] For measurement of the transition temperature, compound (No. 50) was used as a sample as was. For measurement of the maximum temperature (T_{NI}), the dielectric anisotropy ($\Delta\epsilon$) and the optical anisotropy (Δn), a mixture of compound (No. 50) and base liquid crystal (A) was used as a sample. The measurement method was applied also to a compound prepared as described below.

[0132] Transition temperature: C 133.0 N 177.2 I. $T_{NI} = 137.7^{\circ}\text{C}$, $\Delta\epsilon = 6.4$, $\Delta n = 0.357$.

Synthesis Example 3

Synthesis of compound (No. 114)

5 [0133]



30 First step

30 [0134] In a reaction vessel, 0.134 g (0.19 mmol) of Pd-132 and 24.7 g of cesium carbonate were put, and then the reaction vessel was decompressed, and argon was introduced thereto. The operation was repeated 3 times. Compound (r-1) (8.46 g, 37.9 mmol) dissolved in 100 mL of acetonitrile and 3.18 g (37.9 mmol) of 2-methyl-3-butyn-2-ol dissolved in 100 mL of acetonitrile were added thereto, and the resulting mixture was stirred and heated at 80°C for 2 hours under an argon atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane/ethyl acetate = 6/4 in a volume ratio) to obtain 5.33 g of compound (r-6).

Second step

45 [0135] In a reaction vessel, compound (r-6) (3.18 g, 16.5 mmol) dissolved in 60 mL of 1,4-dioxane was put, and 0.078 g (0.11 mmol) of Pd-132, 3.05 g (22.1 mmol) of potassium carbonate and 8 mL of a distilled water were added thereto, and compound (r-7) (3.18 g, 16.5 mmol) dissolved in 20 mL of 1,4-dioxane was added thereto, and the resulting mixture was stirred and heated under reflux for 4 hours under a nitrogen atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane/ethyl acetate = 6/4 in a volume ratio) to obtain 2.98 g of compound (r-8).

Third step

55 [0136] In a reaction vessel, compound (r-8) (2.98 g, 8.80 mmol) dissolved in 60 mL of toluene was put, and 0.54 g (9.60 mmol) of potassium hydroxide ground by a mortar was added thereto, and the resulting mixture was stirred and heated under reflux for 3 hours. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene.

Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane/toluene = 9/1 in a volume ratio) to obtain 1.42 g of compound (r-9).

5 **Fourth step**

[0137] In a reaction vessel, 0.018 g (0.03 mmol) of Pd-132 and 3.30 g of cesium carbonate were put, and then the reaction vessel was decompressed, and argon was introduced thereto. The operation was repeated 3 times. Compound (r-9) (1.42 g, 5.06 mmol) dissolved in 25 mL of acetonitrile and compound (r-10) (1.97 g, 5.06 mmol) dissolved in 25 mL of acetonitrile were added thereto, and the resulting mixture was stirred and heated at 80°C for 4 hours under an argon atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane), and further recrystallized from a mixed solvent (heptane/Solmix A-11 = 1/5 in a volume ratio) to obtain 1.00 g of compound (No. 114).

[0138] $^1\text{H-NMR}$ (δ ppm; CDCl_3): 7.49 (d, 2H), 7.28 (d, 2H), 7.26 (d, 1H), 7.20 (d, 1H), 7.17 (d, 2H), 6.97 (dd, 2H), 2.65 (t, 2H), 2.55 (s, 3H), 1.65 (quin, 2H), 1.38 - 1.32 (m, 4H), 0.91 (t, 3H).

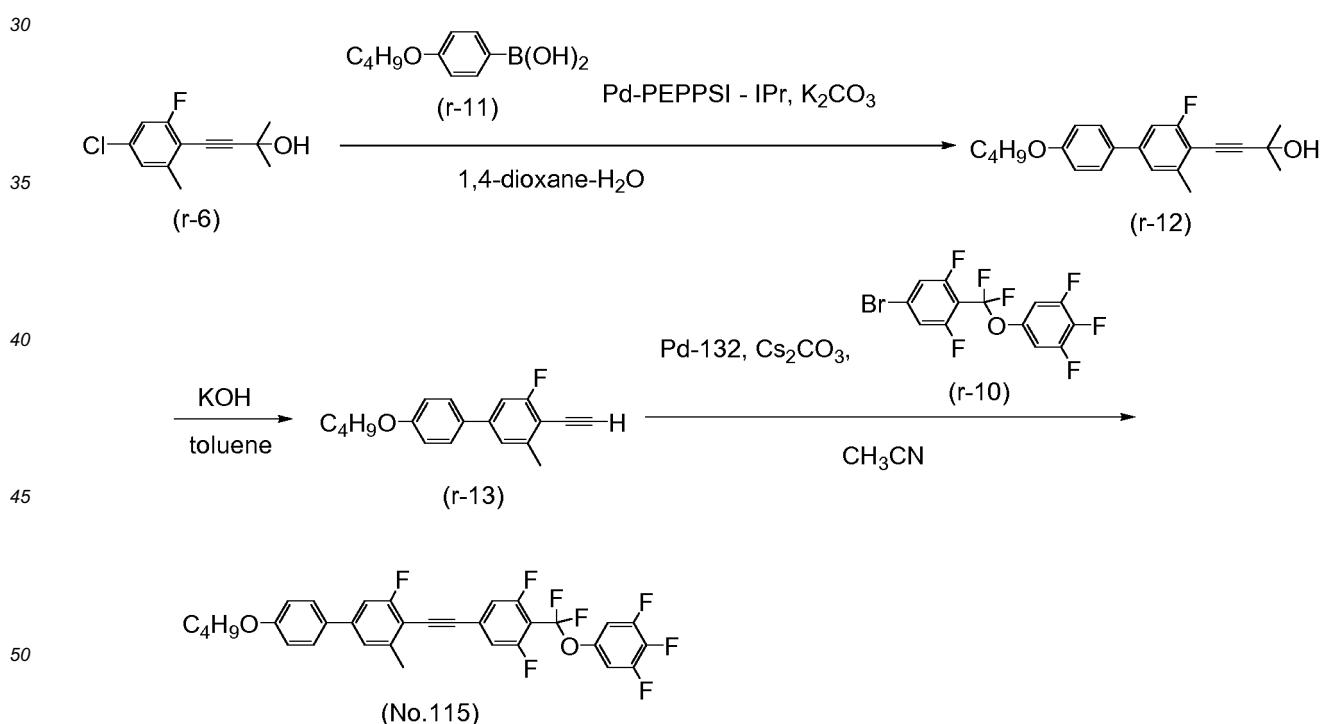
[0139] For measurement of the transition temperature, compound (No. 114) was used as a sample as was. For measurement of the maximum temperature (T_{NI}), the dielectric anisotropy ($\Delta\epsilon$) and the optical anisotropy (Δn), a mixture of compound (No. 114) and base liquid crystal (A) was used as a sample. The measurement method was applied also to a compound prepared as described below.

[0140] Transition temperature: C 101.1 N 122.7 I. T_{NI} = 97.0°C, $\Delta\epsilon$ = 36.6, Δn = 0.257.

25 **Synthesis Example 4**

Synthesis of compound (No. 115)

[0141]



55 **First step**

[0142] In a reaction vessel, compound (r-6) (2.50 g, 11.0 mmol) dissolved in 60 mL of 1,4-dioxane was put, and 0.075 g (0.11 mmol) of [1,3-bis(2,6-diisopropylphenyl)imidazol-2-ylidene](3-chloropyridyl)Palladium(II) dichloride (abbreviated as Pd-PEPPSI-IPr), 3.05 g (22.1 mmol) of potassium carbonate and 8 mL of a distilled water were added thereto, and

compound (r-11) (3.21 g, 16.5 mmol) dissolved in 20 mL of 1,4-dioxane was added thereto, and the resulting mixture was stirred and heated under reflux for 4 hours under a nitrogen atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane/ethyl acetate = 7/3 in a volume ratio) to obtain 3.49 g of compound (r-12).

5

Second step

10 [0143] In a reaction vessel, compound (r-12) (3.49 g, 10.25 mmol) dissolved in 60 mL of toluene was put, and then 0.63 g (11.2 mmol) of potassium hydroxide ground by a mortar was added thereto, and the resulting mixture was stirred and heated under reflux for 3 hours. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate.

15 A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane/toluene = 7/3 in a volume ratio) to obtain 2.24 g of compound (r-13).

15

Third step

20 [0144] In a reaction vessel, 0.028 g (0.04 mmol) of Pd-132 and 5.17 g of cesium carbonate were put, and then the reaction vessel was decompressed, and argon was introduced thereto. The operation was repeated 3 times. Compound (r-13) (2.24 g, 7.93 mmol) dissolved in 37 mL of acetonitrile and compound (r-10) (3.09 g, 7.93 mmol) dissolved in 37 mL of acetonitrile were added thereto, and the resulting mixture was stirred and heated at 80°C for 4 hours under an argon atmosphere. The resulting reaction solution was cooled to room temperature, and then a distilled water was added thereto to stop the reaction, and an aqueous layer thereof was subjected to extraction with toluene. Combined organic layers were washed with saturated brine, and dried over anhydrous magnesium carbonate. A solvent was distilled off under reduced pressure, and the resulting residue was purified by silica gel chromatography (heptane), and further recrystallized from a mixed solvent (heptane/Solmix A-11 = 1/5 in a volume ratio) to obtain 0.71 g of compound (No. 115).

25

[0145] $^1\text{H-NMR}$ (δ ppm; CDCl_3): 7.51 (d, 2H), 7.25 (d, 1H), 7.17 - 7.15 (m, 3H), 6.99 - 6.96 (m, 4H), 4.01 (t, 2H), 2.54 (s, 3H), 1.79 (quin, 2H), 1.52 (Sex, 2H), 0.99 (t, 3H).

30

[0146] For measurement of the transition temperature, compound (No. 115) was used as a sample as was. For measurement of the maximum temperature (T_{NI}), the dielectric anisotropy ($\Delta\epsilon$) and the optical anisotropy (Δn), a mixture of compound (No. 115) and base liquid crystal (A) was used as a sample. The measurement method was applied also to a compound prepared as described below.

35

[0147] Transition temperature: C 111.9 N 156.5 I. T_{NI} = 121.7°C, $\Delta\epsilon$ = 37.9, Δn = 0.297.

40

Example 1

Stability to light

45

[0148] Stability of compound (No. 49) described in Synthesis Example 1 to ultraviolet light was examined.

Measurement method

50

[0149] Stability to ultraviolet light was measured as described below. A sample for measurement was prepared by mixing compound (No. 49) and base liquid crystal (A) at a proportion of 15% by weight and 85% by weight, respectively. A maximum temperature (T_{NI}) of the sample was measured according to a method in measurement method (4). A current amount was measured according to a method of measuring specific resistance as described in measurement method (14). Next, the sample was put in a display device for measuring physical properties, in which silica was obliquely vapor-deposited thereto, and the display device was irradiated with 12 mW/cm² of ultraviolet light for 20 minutes. For irradiation, an ultra high-pressure mercury lamp made by Ushio, Inc. was used. A distance between the light source and the device was set to 20 centimeters. A maximum temperature (NI) and a current amount were measured also for a sample after irradiation. The results were summarized in Table 2.

55

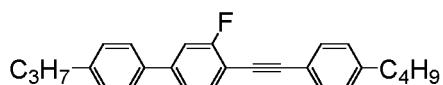
Comparative Example 1

[0150] Comparative compound (C-1) was selected in order to compare with compound (No. 49) described in Example 1 in stability to ultraviolet light. The reason of selecting the compound is that the compound has no alkyl group in a tolan

skeleton part.

Synthesis of comparative compound (C-1)

5 [0151]



(C-1)

15 [0152] $^1\text{H-NMR}$ (δ ppm; CDCl_3) of comparative compound (C-1) : 7.52 (t, 1H), 7.48 (dd, 4H), 7.32 (td, 2H), 7.24 (d, 2H), 7.16 (d, 2H), 2.61 (t, 4H), 1.66 (sex, 2H), 1.59 (quin, 2H), 1.35 (sex, 2H), 0.97 (t, 3H), 0.92 (t, 3H).

[0153] Physical properties of comparative compound (C-1). Transition temperature: C 72.5 S_A 182.5 N 184.5 I. Maximum temperature (T_{NI}) = 151.0°C. Dielectric anisotropy ($\Delta\epsilon$) = 6.77. Optical anisotropy (Δn) = 0.330.

[0154] Stability to ultraviolet light was also measured in comparative compound (C-1) in a manner similar to Example 1. The results were summarized in Table 2.

20 Table 2. Stability to ultraviolet light

Compound contained in sample	Maximum temperature (NI; °C)		Current amount (μA)	
	Before irradiation	After irradiation	Before irradiation	After irradiation
 Compound (No. 49)	78.4	77.9	0.37	0.42
 Comparative compound (C-1)	83.6	77.8	0.39	4.70

Notes: In the maximum temperature, measured values are directly described (without extrapolation).

40 [0155] Even if the sample of compound (No. 49) was irradiated with ultraviolet light, the maximum temperature was decreased only by 0.5°C, but the sample of comparative compound (C-1) was decreased by as high as 5.8°C in the maximum temperature. In the sample of comparative compound (C-1), the current amount after irradiation was significantly increased. The results show that the stability of compound (No. 49) to ultraviolet light was increased in comparison with comparative compound (C-1). In a liquid crystal display device, a backlight is set up on a reverse side of a liquid crystal cell, and a liquid crystal composition is irradiated with the light. Accordingly, a liquid crystal compound that is further stable to ultraviolet light is important from a viewpoint of a service life of the device.

Example 2

50 Stability to light

[0156] A stability of compound (No. 114) described in Synthesis Example 3 to ultraviolet light was examined. A stability to ultraviolet light was measured in a manner similar to Example 1. The results were summarized in Table 3.

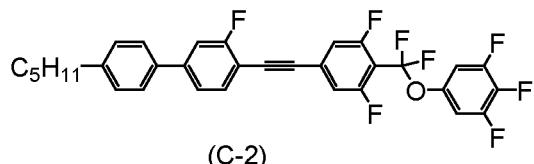
55 Comparative Example 2

[0157] Comparative compound (C-2) was selected in order to compare with compound (No. 114) described in Example 2 in stability to ultraviolet light. The reason of selecting the compound is that the compound has no alkyl group in a tolan

skeleton part.

Synthesis of comparative compound (C-2)

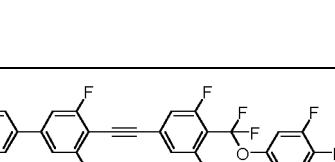
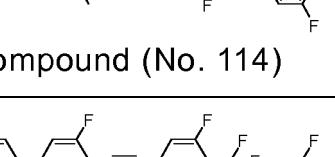
5 [0158]



[0159] $^1\text{H-NMR}$ (δ ppm; CDCl_3) of comparative compound (C-2) : 7.55 (1H, t, J = 7.6 Hz), 7.51 (d, 2H), 7.40 (dd, 1H), 7.36 (dd, 1H), 7.27 (t, 2H), 7.18 (d, 2H), 6.98 (dd, 2H), 2.66 (t, 2H), 1.65 (quin, 2H), 1.36 - 1.34 (m, 4H), 0.91 (t, 3H).

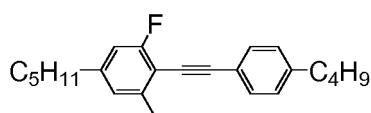
[0160] Transition temperature of comparative compound (C-2): C 60.3 S_A 81.8 N 161.5 l. Maximum temperature (T_{NI}) = 125.7°C. Dielectric anisotropy ($\Delta\epsilon$) = 39.5, optical anisotropy (Δn) = 0.270.

Table 3. Stability to ultraviolet light

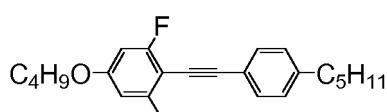
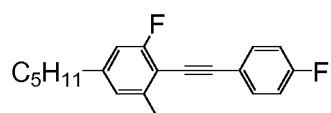
Compound contained in sample	Maximum temperature (NI; °C)		Current amount (μA)	
	Before irradiation	After irradiation	Before irradiation	After irradiation
 Compound (No. 114)	75.5	74.9	0.44	0.52
 Comparative compound (C-2)	79.2	73.8	0.48	6.57

[0161] Stability of comparative compound (C-2) to ultraviolet light was measured in a manner similar to Example 1. The results were summarized in Table 3. As is obvious from Table 3, in a tolan having a bonding group such as $-CF_2O-$, a similar result with Comparative Example 1 was obtained. The above results show that the stability of compound (No. 114) to ultraviolet light was increased in comparison with comparative compound (C-2).

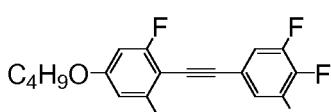
45 [0162] Compound (1) was prepared according to "2. Synthesis of compound (1)" and the Synthesis Examples described above. Examples of such a compound is as described below. In addition, for example, in a description such as C_3H_7- , carbon chain is straight-chain, unless otherwise specifically described.



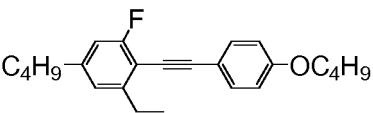
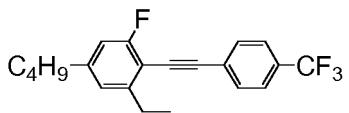
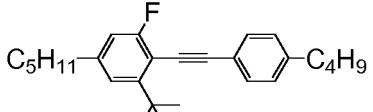
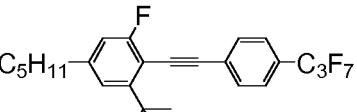
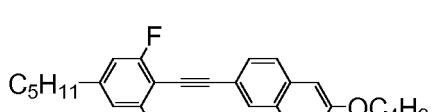
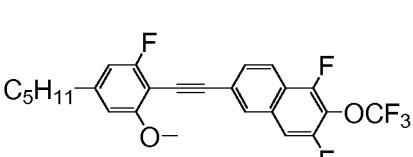
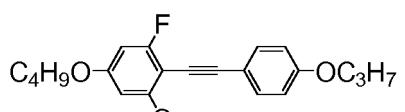
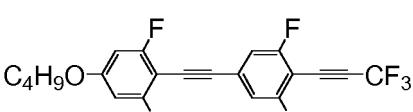
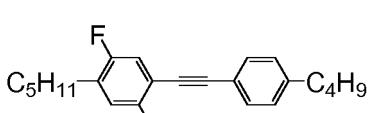
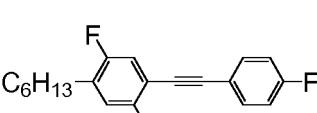
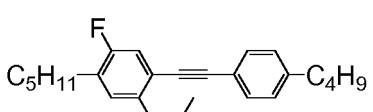
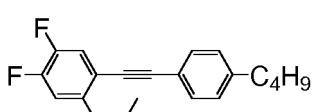
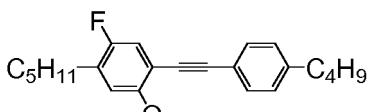
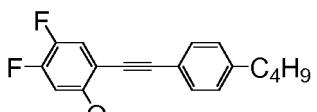
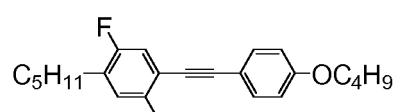
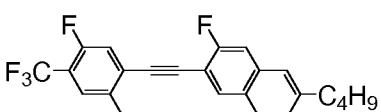
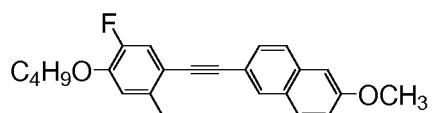
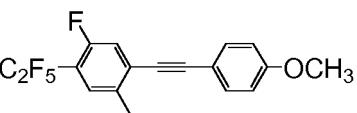
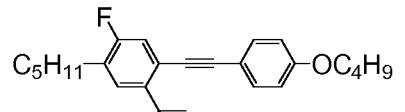
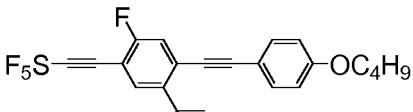
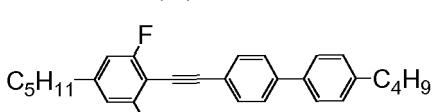
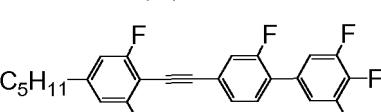
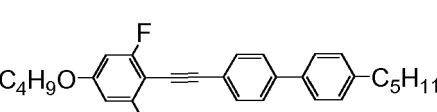
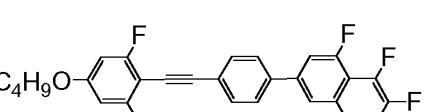
No.
13



No.

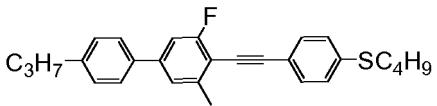
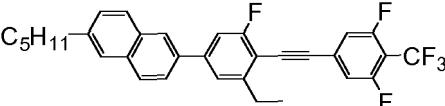
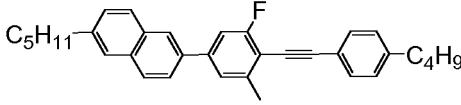
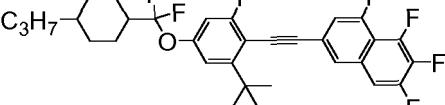
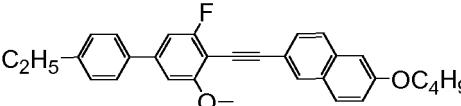
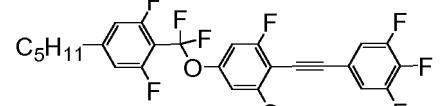
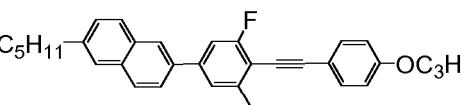
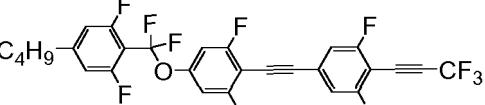
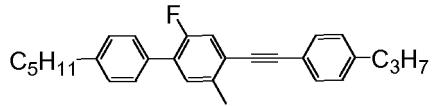
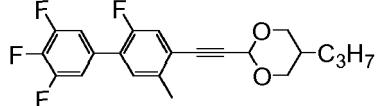
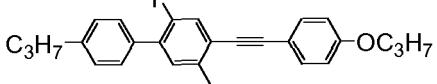
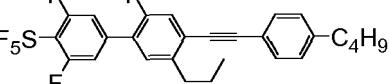
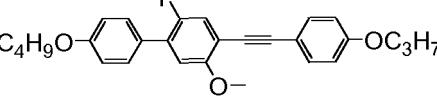
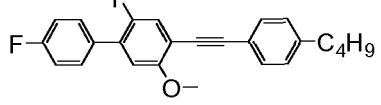
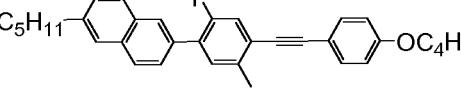
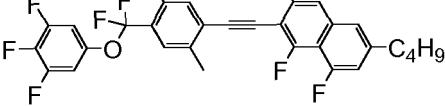
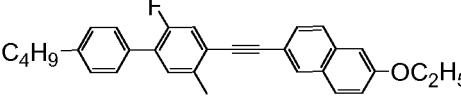
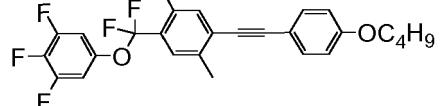
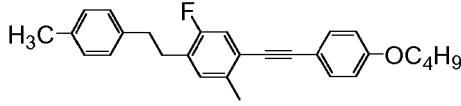
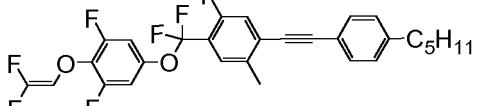
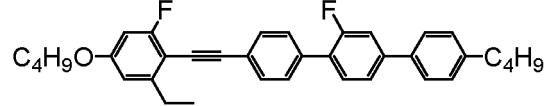


(continued)

5	No. 3		No. 15	
10	No. 4		No. 16	
15	No. 5		No. 17	
20	No. 6		No. 18	
25	No. 7		No. 19	
30	No. 8		No. 20	
35	No. 9		No. 21	
40	No. 10		No. 22	
45	No. 11		No. 23	
50	No. 12		No. 24	
55	No. 25		No. 37	
	No. 26		No. 38	

(continued)

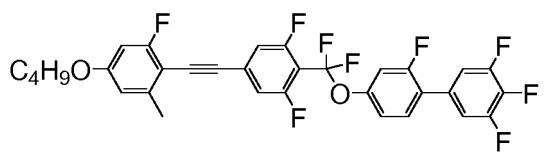
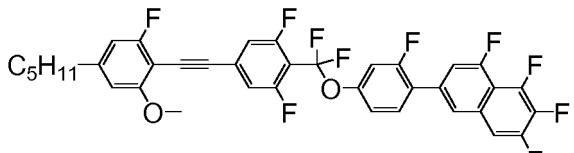
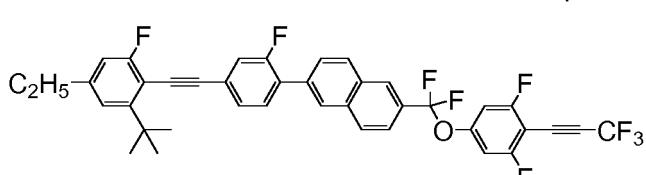
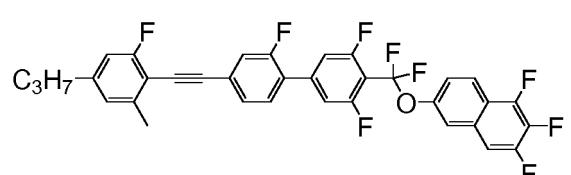
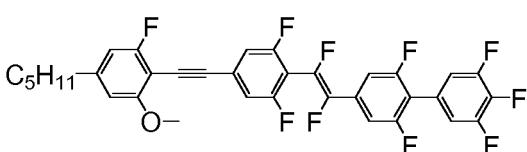
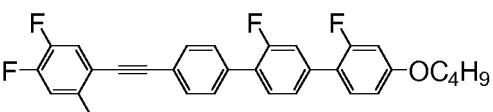
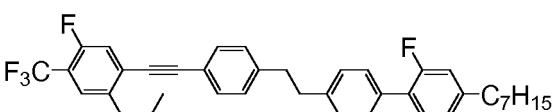
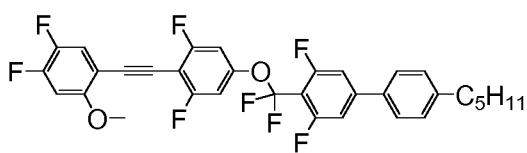
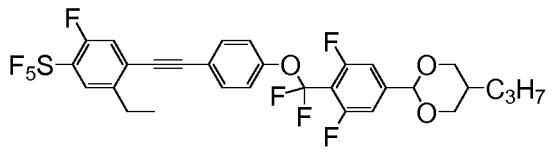
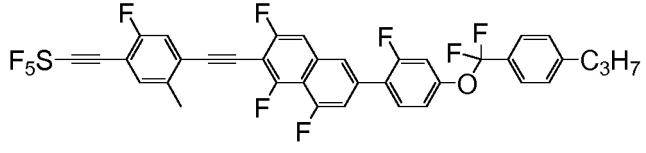
(continued)

5	No. 51		No. 63	
10	No. 52		No. 64	
15	No. 53		No. 65	
20	No. 54		No. 66	
25	No. 55		No. 67	
30	No. 56		No. 68	
35	No. 57		No. 69	
40	No. 58		No. 70	
45	No. 59		No. 71	
50	No. 60		No. 72	
55	No. 73			

(continued)

5	No.74	
10	No.75	
15	No.76	
20	No.77	
25	No.78	
30	No.79	
35	No.80	
40	No.82	
45	No.83	
50	No.84	
55	No.85	

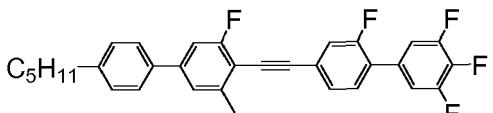
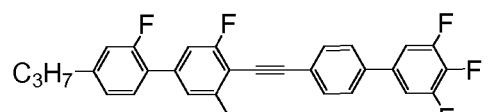
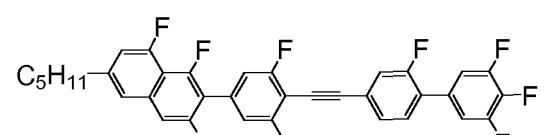
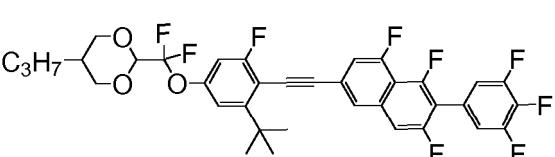
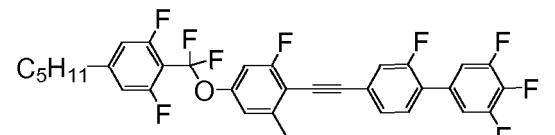
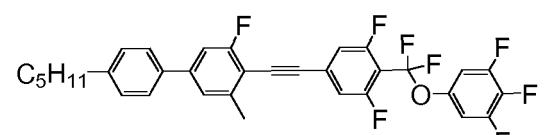
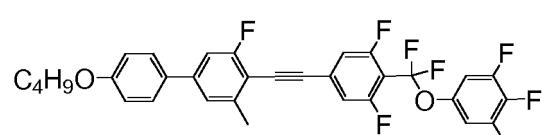
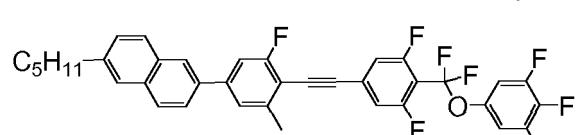
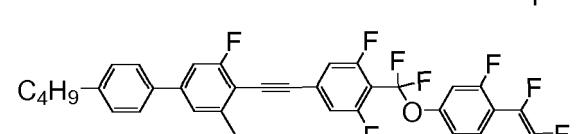
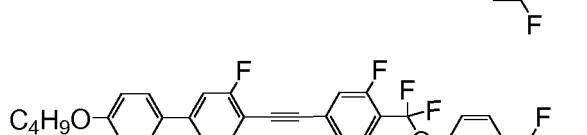
(continued)

5	No.86	
10	No.87	
15	No.88	
20	No.89	
25	No.90	
30	No.91	
35	No.92	
40	No.93	
45	No.94	
50	No.95	

(continued)

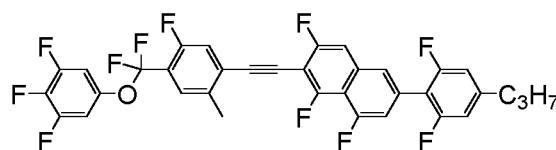
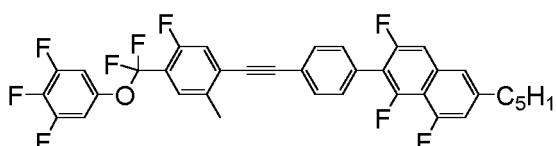
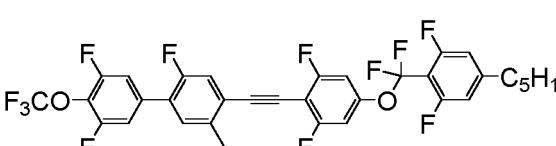
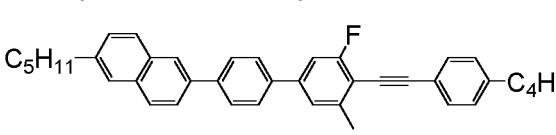
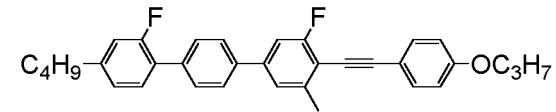
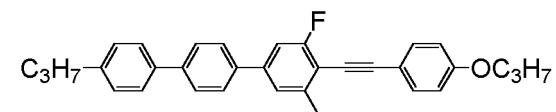
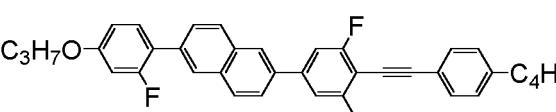
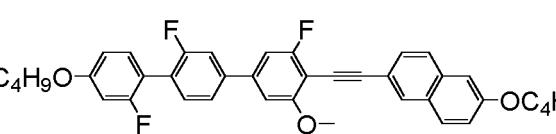
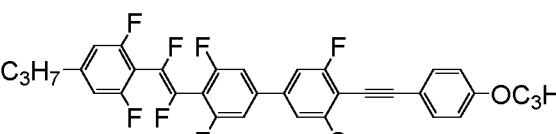
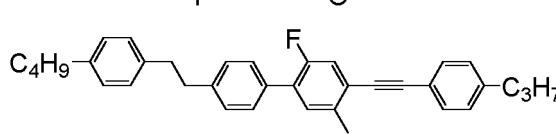
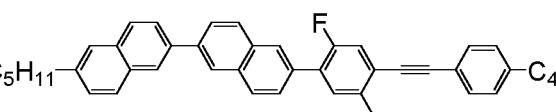
5	No.96	
10	No.97	
15	No.98	
20	No.99	
25	No.100	
30	No.101	
35	No.102	
40	No.103	
45	No.104	
50	No.105	
55	No.106	
	No.107	
	No.108	

(continued)

5	No.109	
10	No.110	
15	No.111	
20	No.112	
25	No.113	
30	No.114	
35	No.115	
40	No.116	
45	No.117	
50	No.118	

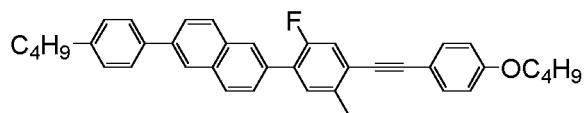
(continued)

(continued)

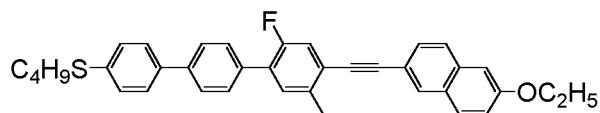
5	No.130	
10	No.131	
15	No.132	
20	No.133	
25	No.134	
30	No.135	
35	No.136	
40	No.137	
45	No.138	
50	No.139	
55	No.140	
	No.141	

(continued)

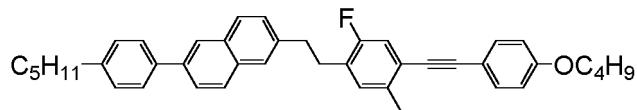
5 No.142



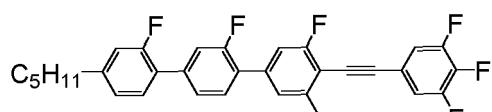
10 No.143



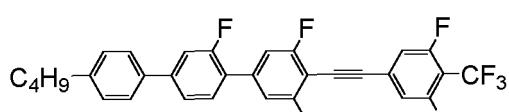
15 No.144



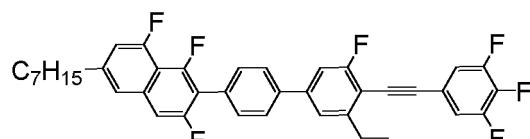
20 No.145



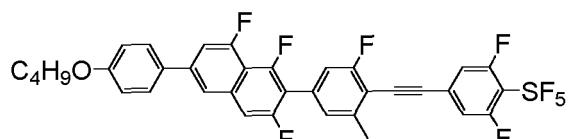
25 No.146



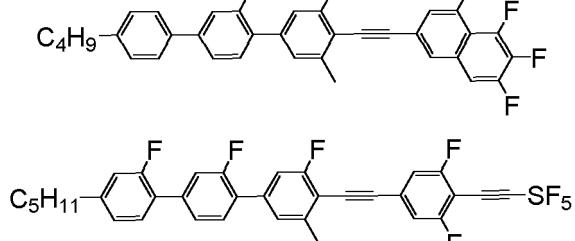
30 No.147



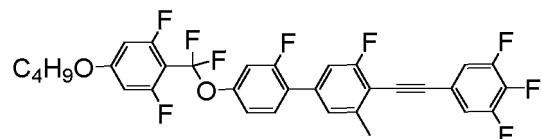
35 No.148



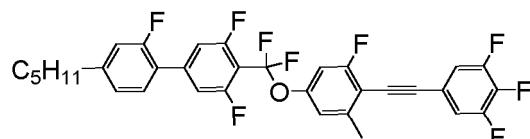
40 No.150



45 No.151



50 No.152



5

10

15

20

25

30

35

40

45

50

55

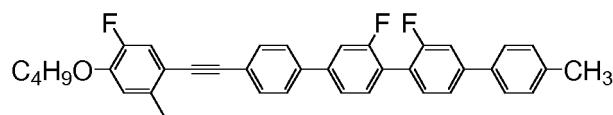
(continued)

(continued)

(continued)

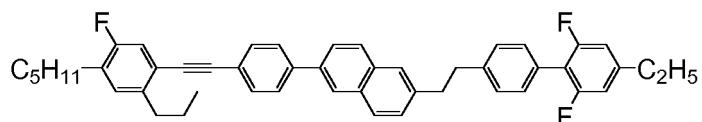
No.175

5



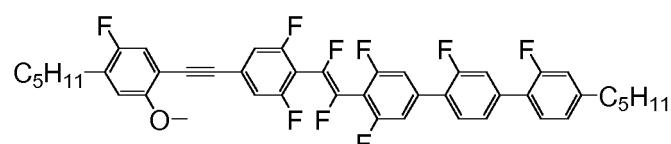
No.176

10



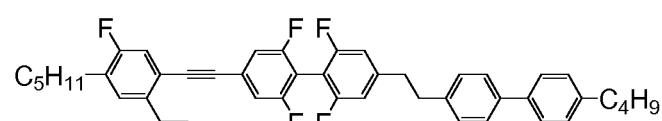
No.177

15



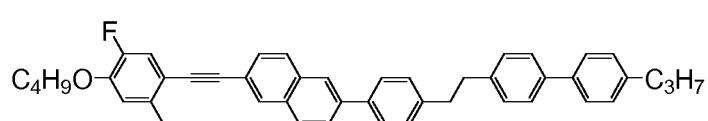
No.178

20



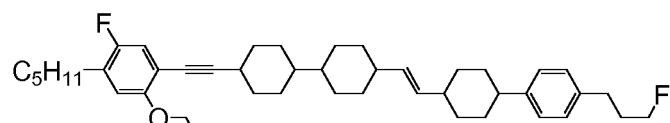
No.179

25



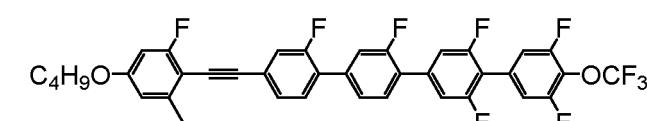
No.180

30



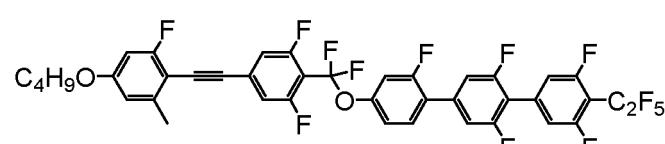
No.181

35



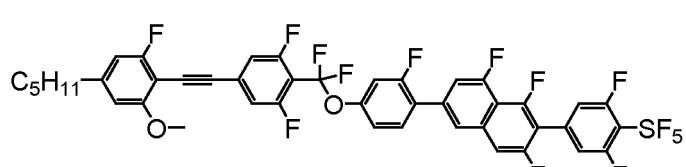
No.182

40



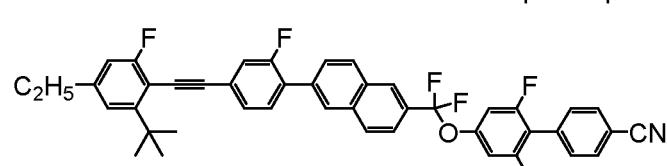
No.183

45



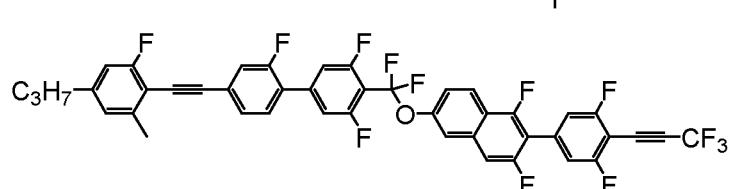
No.184

50



No.185

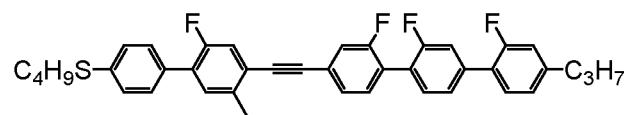
55



(continued)

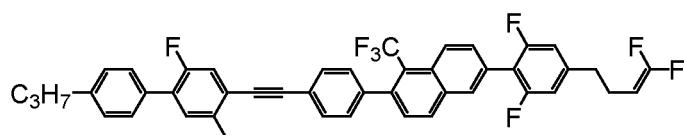
No.198

5



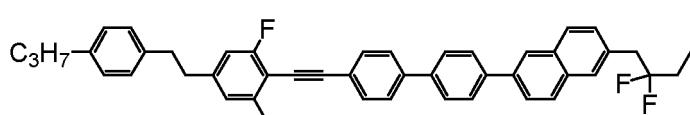
No.199

10



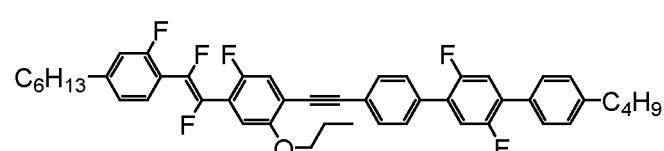
No.200

15



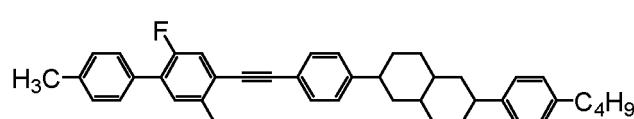
No.201

20



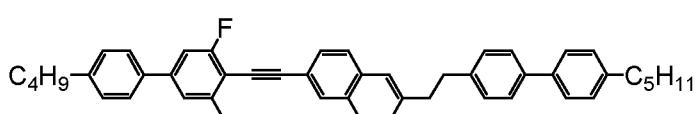
No.202

25



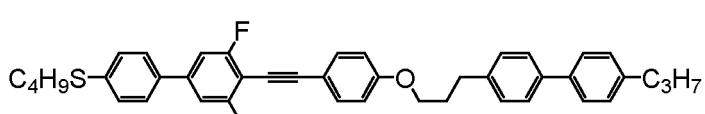
No.203

30



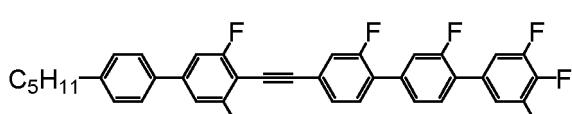
No.204

35



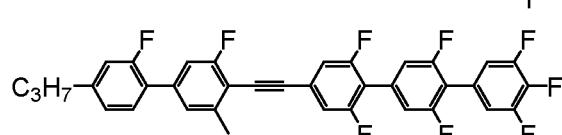
No.205

40



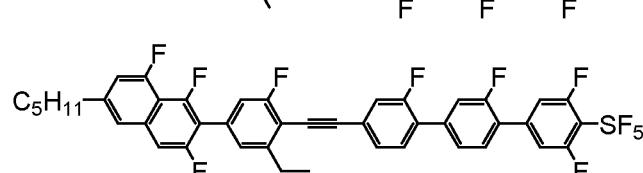
No.206

45



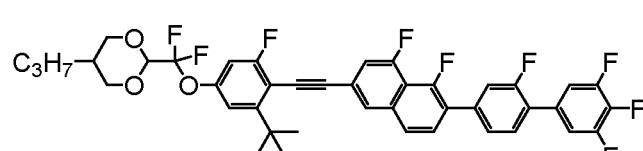
No.207

50



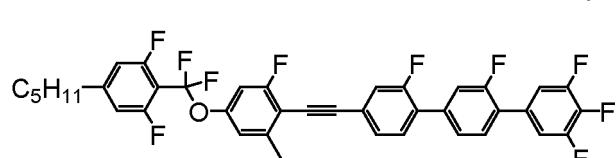
No.208

55



No.209

55

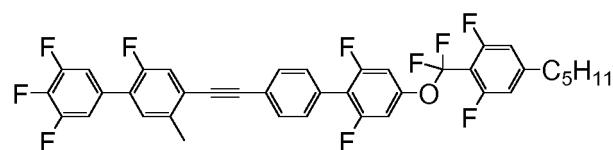


(continued)

(continued)

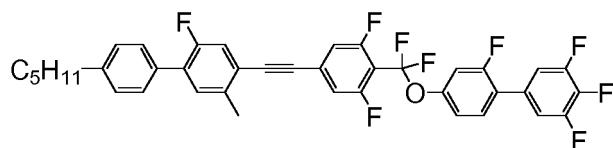
No.221

5



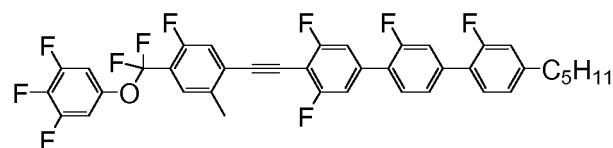
No.222

10



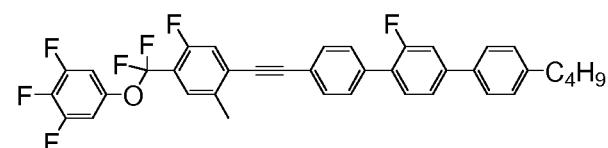
No.223

15



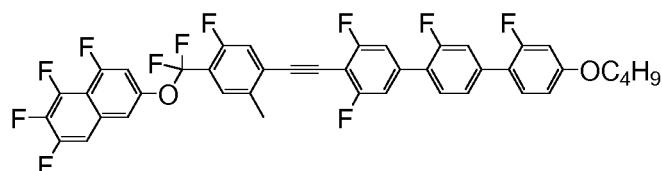
No.224

20



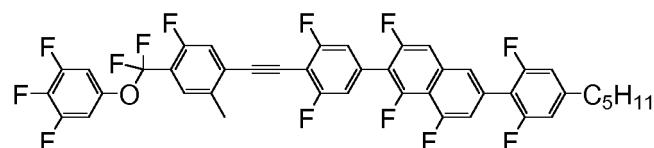
No.225

25



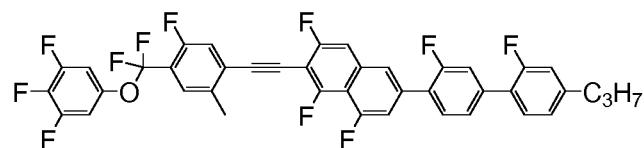
No.226

30



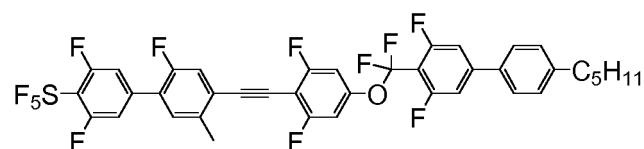
No.227

35



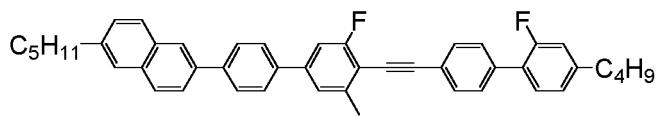
No.228

40



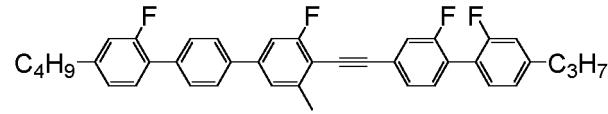
No.229

45



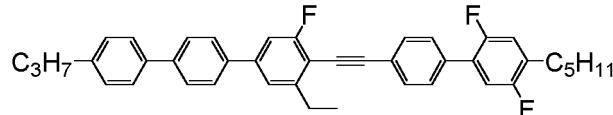
No.230

50



No.231

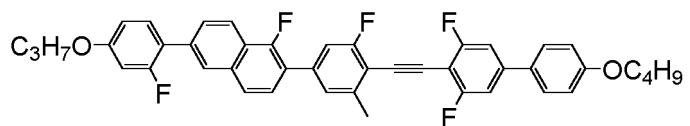
55



(continued)

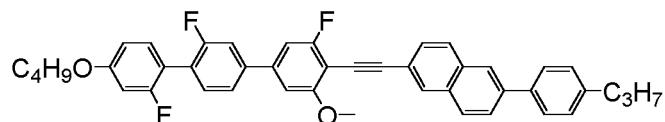
No.232

5



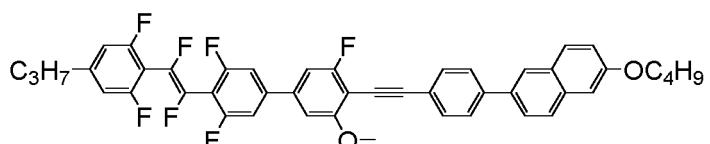
No.233

10



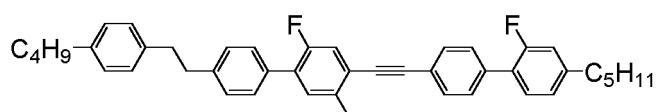
No.234

15



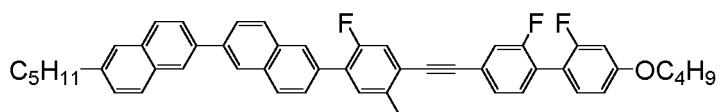
No.235

20



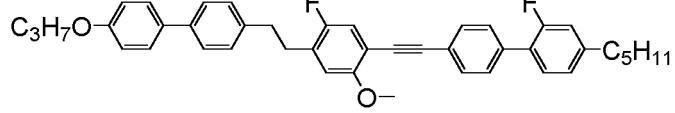
No.236

25



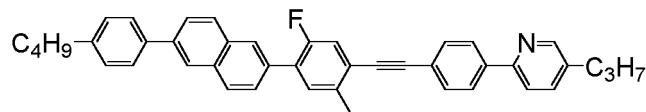
No.237

30



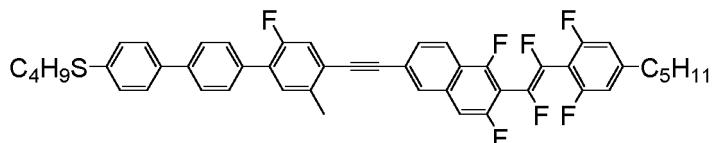
No.238

35



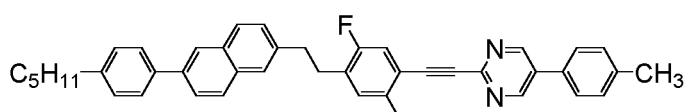
No.239

40



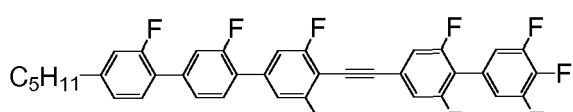
No.240

45



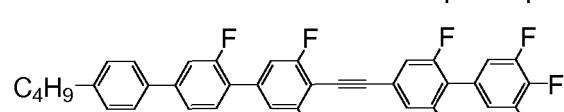
No.241

50



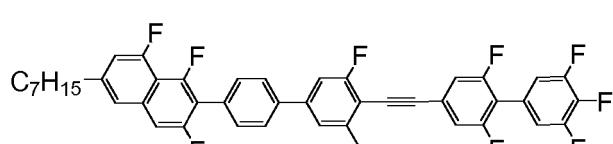
No.242

55



No.243

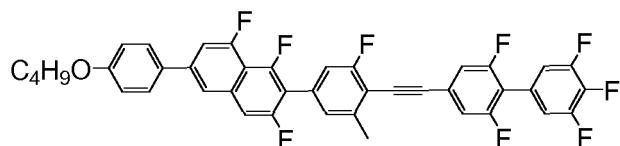
55



(continued)

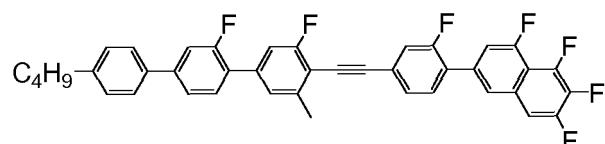
No.244

5



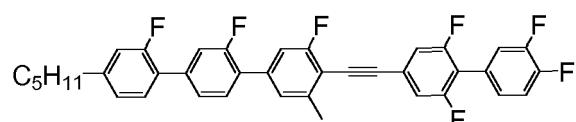
No.245

10



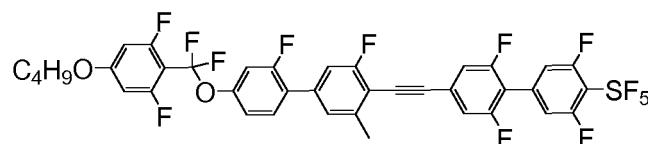
No.246

15



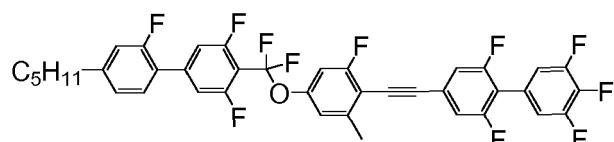
No.247

20



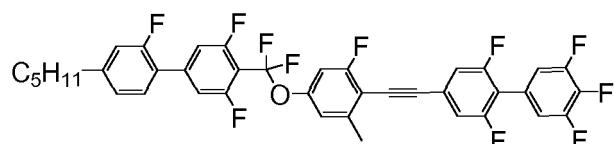
No.248

25



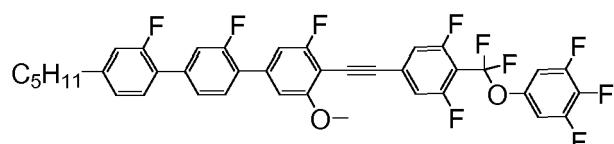
No.249

30



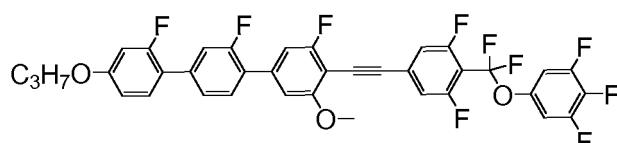
No.250

35



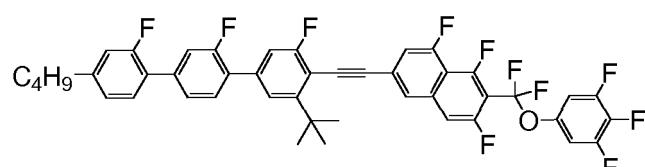
No.251

40



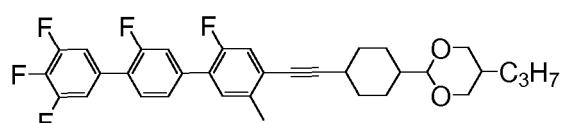
No.252

45



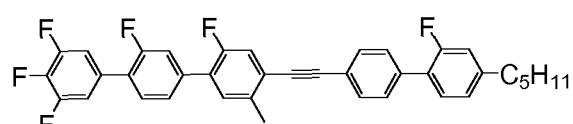
No.253

50

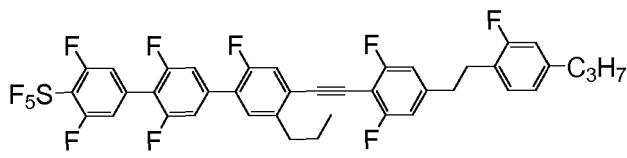
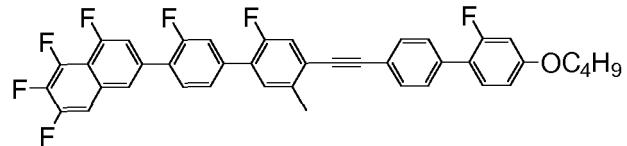
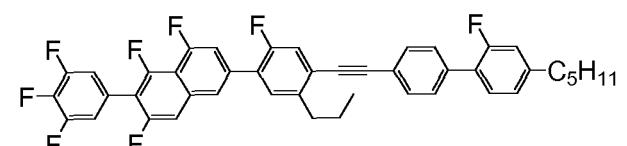
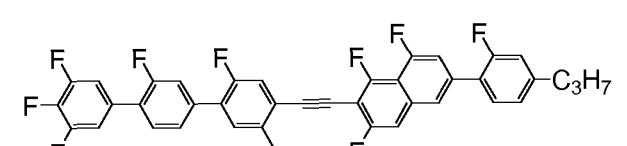
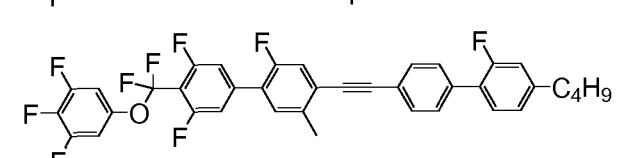
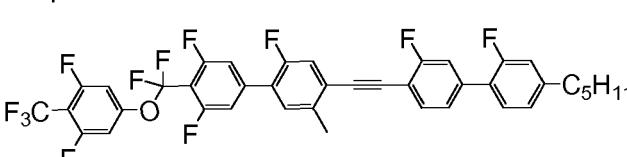
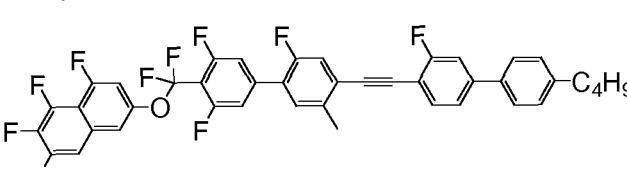
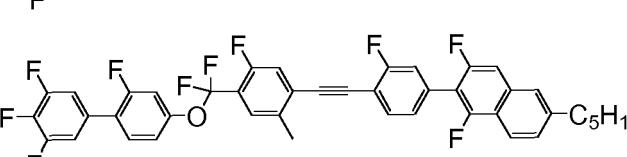
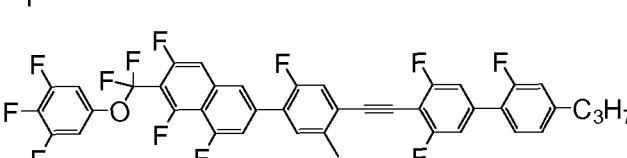
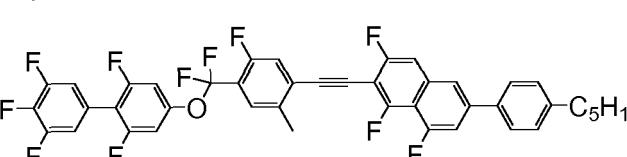


No.254

55

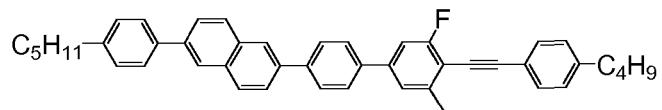


(continued)

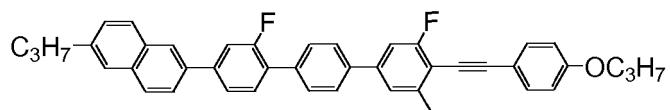
5	No.255	
10	No.256	
15	No.257	
20	No.258	
25	No.259	
30	No.260	
35	No.261	
40	No.262	
45	No.263	
50	No.264	
55		

(continued)

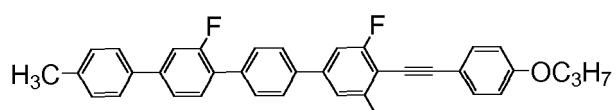
No.265



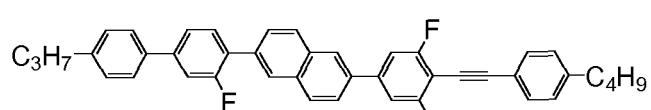
No.266



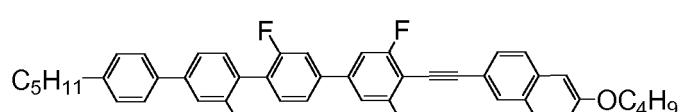
No.267



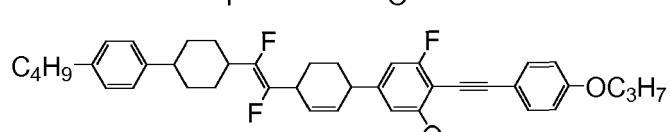
No.268



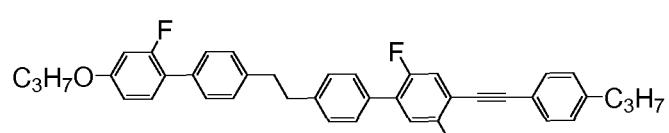
No.269



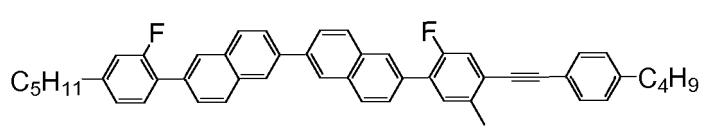
No.270



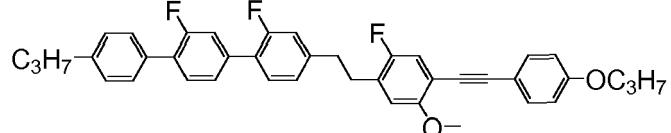
No.271



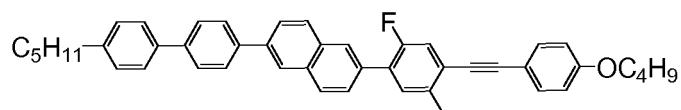
No.272



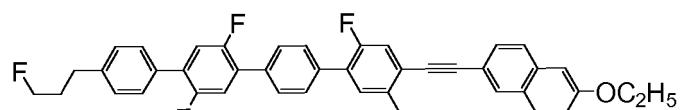
No.273



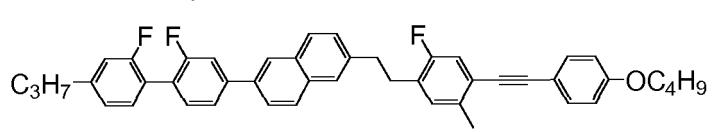
No.274



No.275



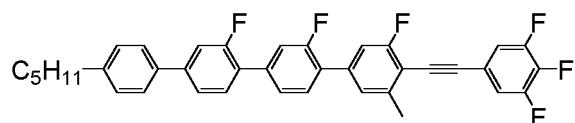
No.276



(continued)

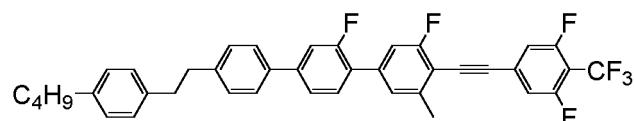
No.277

5



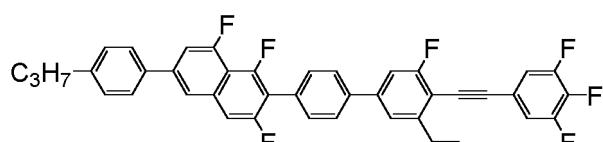
No.278

10



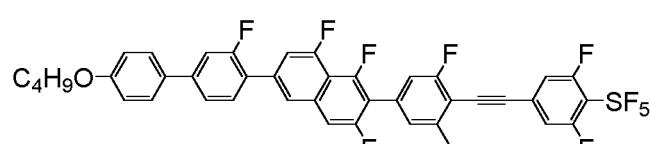
No.279

15



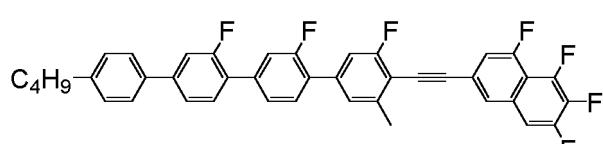
No.280

20



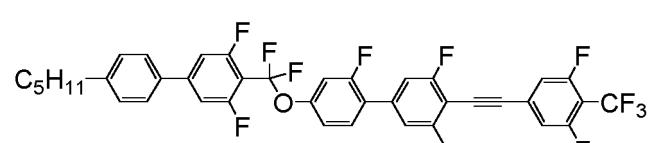
No.281

25



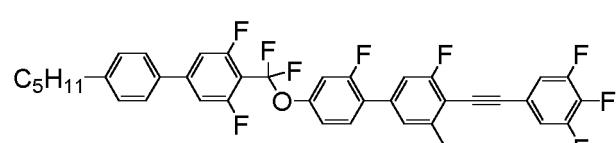
No.282

30



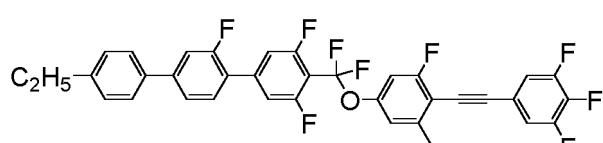
No.283

35



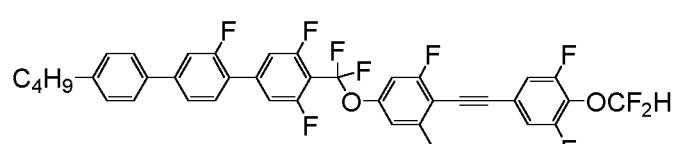
No.284

40



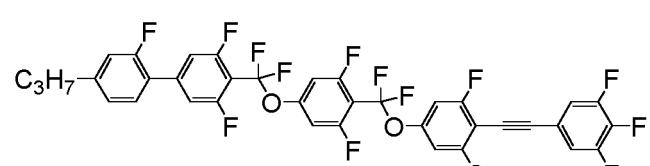
No.285

45



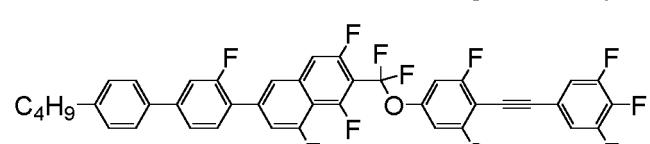
No.286

50



No.287

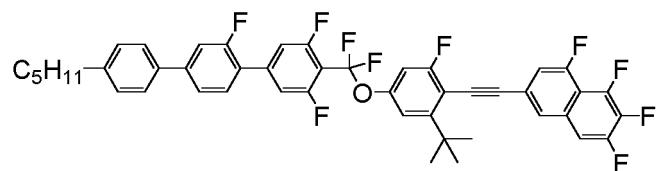
55



(continued)

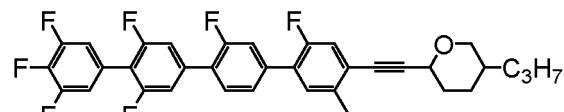
No.288

5



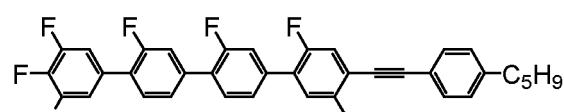
No.289

10



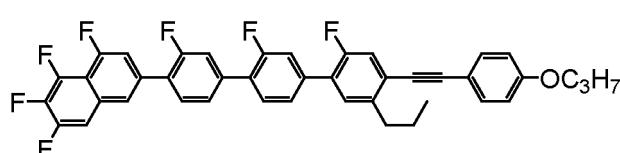
No.290

15



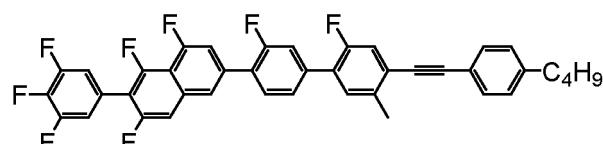
No.291

20



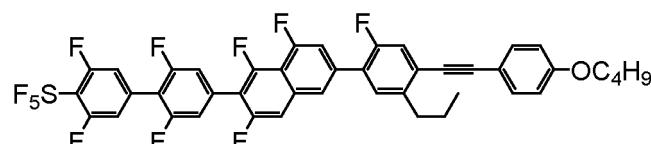
No.292

25



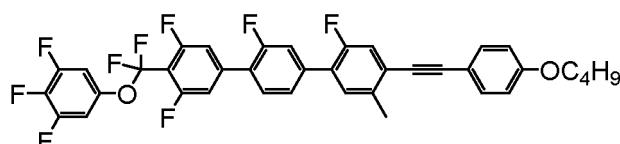
No.293

30



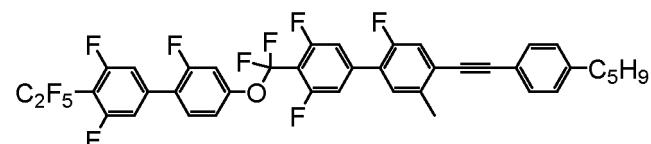
No.294

35



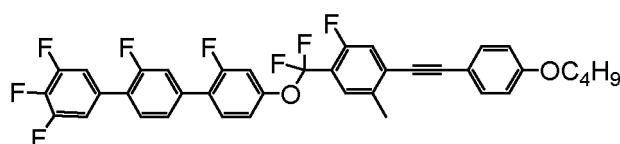
No.295

40



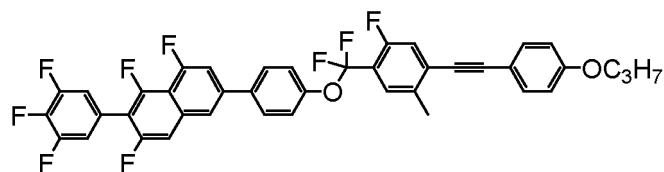
No.296

45



No.297

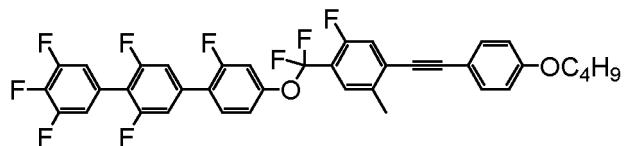
50



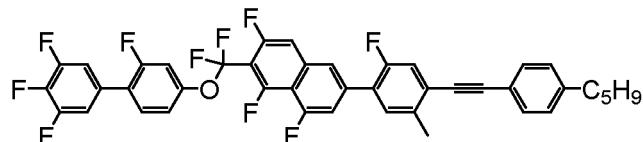
55

(continued)

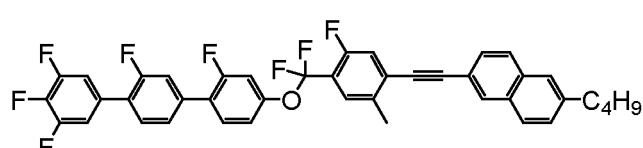
No.298



No.299



No.300



2. Examples of composition

[0163] The invention will be described in greater detail by way of Examples. The Examples include a typical example, and therefore the invention is not limited by the Examples. For example, in addition to compositions in Use Examples, the invention includes a mixture of the composition in Use Example 1 and the composition in Use Example 2. The invention also includes a mixture prepared by mixing at least two compositions in Use Examples. Compounds in Use Examples were represented using symbols according to definitions in Table 4 described below. In Table 4, the configuration with regard to 1,4-cyclohexylene is trans. A parenthesized number next to a symbolized compound represents a chemical formula to which the compound belongs. A symbol (-) means a liquid crystal compound different from compounds (1) to (15). A proportion (percentage) of the liquid crystal compound is expressed in terms of weight percent (% by weight) based on the weight of the liquid crystal composition containing no additive. Values of the physical properties of the composition are summarized in a last part. The physical properties were measured according to the methods described above, and measured values are directly described (without extrapolation).

35

40

45

50

55

Table 4. Method for description of compounds using symbols
R-(A₁)-Z₁-···-Z_n-(A_n)-R'

	1) Left-terminal group R-	Symbol	4) Ring structure	-A _n -	Symbol
5	C _n H _{2n+1} -	n-		H	
	C _n H _{2n+1} O-	nO-		B	
	C _m H _{2m+1} OC _n H _{2n} -	mOn-		B(F)	
10	C _n H _{2n+1} S-	nS-		B(2F)	
	CH ₂ =CH-	V-		B(F,F)	
	C _n H _{2n+1} -CH=CH-	nV-		B(2F,5F)	
	CH ₂ =CH-C _n H _{2n} -	Vn-		B(2F,3F)	
15	C _m H _{2m+1} -CH=CH-C _n H _{2n} -	mVn-		B(F,Me)	
	CF ₂ =CH-	VFF-		B(2F,5Me)	
	CF ₂ =CH-C _n H _{2n} -	VFFn-		Py	
	2) Right-terminal group -R'	Symbol			
	-C _n H _{2n+1}	-n			
	-OC _n H _{2n+1}	-On			
20	-SC _n H _{2n+1}	-Sn			
	-COOCH ₃	-EMe			
	-CH=CH ₂	-V			
	-CH=CH-C _n H _{2n+1}	-Vn			
	-C _n H _{2n} -CH=CH ₂	-nV			
25	-C _m H _{2m} -CH=CH-C _n H _{2n+1}	-mVn			
	-CH=CF ₂	-VFF			
	-F	-F			
	-Cl	-CL			
30	-OCF ₃	-OCF3			
	-OCF ₂ H	-OCF2H			
	-CF ₃	-CF3			
	-OCH=CH-CF ₃	-OVCF3			
	-C≡N	-C			
35	3) Bonding group -Z _n -	Symbol			
	-C _n H _{2n} -	n		ch	
	-COO-	E		Dh	
	-CH=CH-	V		dh	
40	-CH ₂ O-	1O		Cro(7F,8F)	
	-OCH ₂ -	O1			
	-CF ₂ O-	X			
	-C≡C-	T			
45				Np	
					Np(1F,3F)
	5) Examples of description				
	Example 1 3-BB(F,Me)TB-4		Example 2 3-BB(F,F)XB(F,F)-F		
50					
	Example 3 3-HB-O2		Example 4 3-HBB(2F,3F)-O2		
55					

Use Example 1

[0164]

5	3-BB(F,Me)TB-4	(No. 49)	8 %
10	7-HB(F,F)-F	(5-4)	3 %
15	3-HB-O2	(2-5)	7%
20	2-HHB(F)-F	(6-2)	8 %
25	3-HHB(F)-F	(6-2)	7%
	5-HHB(F)-F	(6-2)	9 %
	2-HBB(F)-F	(6-23)	8 %
	3-HBB(F)-F	(6-23)	10%
	5-HBB(F)-F	(6-23)	15%
	2-HBB-F	(6-22)	4%
	3-HBB-F	(6-22)	3%
	5-HBB-F	(6-22)	3%
	3-HBB(F,F)-F	(6-24)	5 %
	5-HBB(F,F)-F	(6-24)	10%

[0165] NI = 87.0°C; η = 26.0 mPa·s; Δn = 0.132; $\Delta \varepsilon$ = 5.7.

Use Example 2

[0166]

35	3-BB(F,Me)TB-O3	(No. 50)	3%
40	5-HB-CL	(5-2)	16%
45	7-HB(F,F)-F	(5-4)	3%
50	3-HH-4	(2-1)	10%
	3-HH-5	(2-1)	6%
	3-HB-O2	(2-5)	12%
	3-HHB-1	(3-1)	8 %
	3-HHB-O1	(3-1)	4%
	2-HHB(F)-F	(6-2)	5%
	3-HHB(F)-F	(6-2)	7%
	5-HHB(F)-F	(6-2)	7%
	3-HHB(F,F)-F	(6-3)	7%
	3-H2HB(F,F)-F	(6-15)	6%
	4-H2HB(F,F)-F	(6-15)	6%

[0167] NI = 73.9°C; η = 15.5 mPa·s; Δn = 0.082; $\Delta \varepsilon$ = 3.1.

Use Example 3

[0168]

5	5-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 114)	10%
10	5-HB-CL	(5-2)	14%
15	3-HH-4	(2-1)	12%
20	3-HH-5	(2-1)	3%
25	3-HHB-F	(6-1)	3%
30	3-HHB-CL	(6-1)	3%
	4-HHB-CL	(6-1)	4%
	3-HHB(F)-F	(6-2)	9%
	4-HHB(F)-F	(6-2)	6%
	5-HHB(F)-F	(6-2)	6%
	7-HHB(F)-F	(6-2)	10%
	5-HBB(F)-F	(6-23)	3%
	1O1-HBBH-5	(4-1)	3%
	3-HHBB(F,F)-F	(7-6)	2%
	4-HHBB(F,F)-F	(7-6)	3%
	5-HHBB(F,F)-F	(7-6)	3%
	3-HH2BB(F,F)-F	(7-15)	3%
	4-HH2BB(F,F)-F	(7-15)	3%

[0169] NI = 115.4°C; $\eta = 26.6 \text{ mPa}\cdot\text{s}$; $\Delta n = 0.108$; $\Delta \varepsilon = 6.8$.

Use Example 4

[0170]

40	4O-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 115)	3%
45	2-HH-5	(2-1)	3%
50	3-HH-4	(2-1)	14%
55	3-HH-5	(2-1)	3%
	3-HB-O2	(2-5)	11%
	2-BB(2F,3F)-O2	(9-3)	12%
	5-H2B(2F,3F)-O2	(9-4)	15%
	3-HHB(2F,3CL)-O2	(10-12)	5%
	V-HBB(2F,3F)-O2	(10-7)	6%
	3-HBB(2F,3F)-O2	(10-7)	7%
	5-HBB(2F,3F)-O2	(10-7)	5%
	3-HHB-1	(3-1)	3%
	3-HHB-3	(3-1)	4%
	3-HHB-O1	(3-1)	3%

(continued)

5

3-HH2B(2F,3F)-O2	(10-4)	3%
3-DhB(2F,3F)-O2	(9-2)	3%

Use Example 5**[0171]**

10

15

20

25

30

3-BB(F,Me)TB-S4	(No. 51)	3%
3-HHB(F,F)-F	(6-3)	8 %
3-H2HB(F,F)-F	(6-15)	7%
4-H2HB(F,F)-F	(6-15)	7%
5-H2HB(F,F)-F	(6-15)	7%
3-HBB(F,F)-F	(6-24)	20%
5-HBB(F,F)-F	(6-24)	21%
3-H2BB(F,F)-F	(6-27)	11%
5-HHBB(F,F)-F	(7-6)	4%
5-HHEBB-F	(7-17)	3%
3-HH2BB(F,F)-F	(7-15)	3%
1O1-HBBH-4	(4-1)	3%
1O1-HBBH-5	(4-1)	3%

Use Example 6**[0172]**

35

40

45

50

55

5-NpB(F,Me)TB-O3	(No. 54)	3%
3-GB(F)B(F,F)XB(F,F)-F	(7-57)	5%
4-GB(F)B(F,F)XB(F,F)-F	(7-57)	4%
5-GB(F)B(F,F)XB(F,F)-F	(7-57)	3%
3-GB(F)B(F,F)XB(F,F)-F	(7-57)	4%
4-BB(F)B(F,F)XB(F,F)-F	(7-57)	3%
3-HH-V	(2-1)	34%
3-HH-V1	(2-1)	8%
3-HHEH-5	(3-13)	4%
3-HHB-1	(3-1)	5%
V-HHB-1	(3-1)	5%
V2-BB(F)B-1	(3-6)	5%
1V2-BB-F	(5-1)	3%
3-BB(F,F)XB(F,F)-F	(6-97)	6%
3-GB(F,F)XB(F,F)-F	(6-113)	5%
3-HHBB(F,F)-F	(7-6)	3%

Use Example 7

[0173]

5	5-NpB(F,Me)TB(F,F)XB(F,F)-F	(No. 116)	5%
10	5-HB-CL	(5-2)	8 %
15	3-HH-4	(2-1)	7%
20	3-HHB-1	(3-1)	6%
25	3-HHB(F,F)-F	(6-3)	5%
	3-HBB(F,F)-F	(6-24)	16%
	5-HBB(F,F)-F	(6-24)	14%
	3-HHEB(F,F)-F	(6-12)	11%
	4-HHEB(F,F)-F	(6-12)	5%
	5-HHEB(F,F)-F	(6-12)	5%
	2-HBEB(F,F)-F	(6-39)	6%
	3-HBEB(F,F)-F	(6-39)	4%
	5-HBEB(F,F)-F	(6-39)	3%
	3-HHBB(F,F)-F	(7-6)	5%

Use Example 8

[0174]

30	4O-BB(F,Me)TB(F,F)XNp(1F,3F)-F	(No. 118)	3%
35	2-dhBB(F,F)XB(F,F)-F	(7-50)	4%
40	3-dhBB(F,F)XB(F,F)-F	(7-50)	5%
45	5-HB(F)B(F,F)XB(F,F)-F	(7-41)	3%
50	3-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
	4-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
	5-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
	3-HH-V	(2-1)	38%
	3-HH-V1	(2-1)	5%
	3-HHEH-5	(3-13)	5%
	3-HHB-1	(3-1)	5%
	V-HHB-1	(3-1)	4%
	V2-BB(F)B-1	(3-6)	4%
	1V2-BB-F	(5-1)	3%
	3-BB(F,F)XB(F,F)-F	(6-97)	9 %
	3-HHBB(F,F)-F	(7-6)	3%

55 Use Example 9

[0175]

5	4S-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 120)	3 %
10	5-HB-CL	(5-2)	4 %
15	7-HB(F)-F	(5-3)	5 %
20	3-HH-4	(2-1)	7 %
25	3-HH-5	(2-1)	8%
30	3-HB-O2	(2-5)	11%
35	3-HHEB-F	(6-10)	10%
40	5-HHEB-F	(6-10)	10%
45	3-HHEB(F,F)-F	(6-12)	6%
50	4-HHEB(F,F)-F	(6-12)	6%
55	3-GHB(F,F)-F	(6-109)	6%
60	4-GHB(F,F)-F	(6-109)	6%
65	5-GHB(F,F)-F	(6-109)	6%
70	2-HHB(F,F)-F	(6-3)	6%
75	3-HHB(F,F)-F	(6-3)	6%

25 **Use Example 10****[0176]**

30	3-BB(2F,5Me)TB-O3	(No. 56)	3%
35	2-HB-C	(8-1)	6%
40	3-HB-C	(8-1)	14%
45	3-HB-O2	(2-5)	12%
50	2-BTB-1	(2-10)	4%
55	3-HHB-F	(6-1)	5%
60	3-HHB-1	(3-1)	7%
65	3-HHB-O1	(3-1)	4%
70	3-HHB-3	(3-1)	13%
75	3-HHEB-F	(6-10)	5%
80	5-HHEB-F	(6-10)	3%
85	2-HHB(F)-F	(6-2)	8 %
90	3-HHB(F)-F	(6-2)	6%
95	5-HHB(F)-F	(6-2)	6%
100	3-HHB(F,F)-F	(6-3)	4%

Use Example 11**[0177]**

55	3-BB(F,Me)TB-4	(No. 49)	5 %
60	5-HB-F	(5-2)	12%

(continued)

5	6-HB-F	(5-2)	9 %
10	7-HB-F	(5-2)	7%
15	2-HHB-OCF3	(6-1)	5%
20	3-HHB-OCF3	(6-1)	5%
25	4-HHB-OCF3	(6-1)	7%
30	5-HHB-OCF3	(6-1)	6%
35	3-HH2B-OCF3	(6-4)	3%
40	5-HH2B-OCF3	(6-4)	4%
45	3-HHB(F,F)-OCF2H	(6-3)	5%
50	3-HHB(F,F)-OCF3	(6-3)	3%
55	3-HH2B(F)-F	(6-5)	3 %
60	3-HBB(F)-F	(6-23)	8%
65	5-HBB(F)-F	(6-23)	10%
70	5-HBBH-3	(4-1)	5%
75	3-HB(F)BH-3	(4-2)	3%

[0178] NI = 89.7°C; η = 16.2 mPa·s; Δn = 0.104; $\Delta \epsilon$ = 4.2.

Use Example 12

[0179]

35	3-BB(F,Me)TB-O3	(No. 50)	3%
40	3-HB-CL	(5-2)	10%
45	3-HH-4	(2-1)	10%
50	3-HB-O2	(2-5)	10%
55	3-HHB(F,F)-F	(6-3)	5%
60	3-HBB(F,F)-F	(6-24)	25%
65	5-HBB(F,F)-F	(6-24)	25%
70	5-HBB(F)B-2	(4-5)	6%
75	5-HBB(F)B-3	(4-5)	6%

[0180] NI = 78.3°C; η = 21.4 mPa·s; Δn = 0.127; $\Delta \epsilon$ = 5.5.

Use Example 13

[0181]

55	5-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 114)	9%
60	2-HH-3	(2-1)	5%
65	2-HH-5	(2-1)	10%
70	3-HH-4	(2-1)	4%
75	7-HB-1	(2-5)	8 %

(continued)

5	5-HB-O2	(2-5)	6%
10	3-HB(2F,3F)-O2	(9-1)	14%
15	5-HB(2F,3F)-O2	(9-1)	15%
	3-HHB(2F,3CL)-O2	(10-12)	3%
	4-HHB(2F,3CL)-O2	(10-12)	3%
	5-HHB(2F,3CL)-O2	(10-12)	3%
	5-HBB(2F,3F)-O2	(10-7)	4%
	3-HH1OCro(7F,8F)-5	(13-6)	3%
	5-HBB(F)B-2	(4-5)	7%
	5-HBB(F)B-3	(4-5)	6%

Use Example 14

20 [0182]

25	40-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 115)	3%
30	3-HB-O1	(2-5)	13%
35	3-HH-4	(2-1)	5%
	3-HH-VFF	(2-1)	10%
	V-HB(2F,3F)-O2	(9-1)	10%
	5-HB(2F,3F)-O2	(9-1)	10%
	2-HHB(2F,3F)-1	(10-1)	10%
	3-HHB (2F, 3F)-1	(10-1)	10%
	3-HHB(2F,3F)-O2	(10-1)	10%
	5-HHB(2F,3F)-O2	(10-1)	10%
	3-HHB-1	(3-1)	4%
	1-BB-5	(2-8)	5%

Use Example 15

40 [0183]

45	3-BB(F,Me)TB-S4	(No. 51)	3%
50	3-HB-O1	(2-5)	12%
55	3-HH-4	(2-1)	8%
	3-HB(2F,3F)-O2	(9-1)	10%
	5-HB(2F,3F)-O2	(9-1)	10%
	2-HHB(2F,3F)-1	(10-1)	13%
	3-HHB(2F,3F)-1	(10-1)	11%
	3-HHB(2F,3F)-O2	(10-1)	11%
	5-HHB(2F,3F)-O2	(10-1)	14%

(continued)

3-HHB-1	(3-1)	8%
---------	-------	----

5 **Use Example 16****[0184]**

10	5-NpB(F,Me)TB-O3	(No. 54)	2%
15	2-HH-5	(2-1)	5%
20	3-HH-4	(2-1)	13%
25	3-HH-5	(2-1)	5%
30	3-HB-O2	(2-5)	10%
	3-H2B(2F,3F)-O2	(9-4)	14%
	5-H2B(2F,3F)-O2	(9-4)	13%
	3-HHB(2F,3CL)-O2	(10-12)	5%
	2-HBB(2F,3F)-O2	(10-7)	5%
	3-HBB(2F,3F)-O2	(10-7)	8%
	5-HBB(2F,3F)-O2	(10-7)	8%
	3-HHB-1	(3-1)	5%
	3-HHB-3	(3-1)	4%
	3-HHB-O1	(3-1)	3%

Use Example 17**[0185]**

35	5-NpB(F,Me)TB(F,F)XB(F,F)-F	(No. 116)	6%
40	2-HH-3	(2-1)	18%
45	3-HH-4	(2-1)	7%
50	1-BB-3	(2-8)	8 %
	3-HB-O2	(2-5)	3%
	3-BB(2F,3F)-O2	(9-3)	10%
	5-BB(2F,3F)-O2	(9-3)	5 %
	2-HH1OB(2F,3F)-O2	(10-5)	15%
	3-HH1OB(2F,3F)-O2	(10-5)	20%
	3-HHB-1	(3-1)	3%
	3-HHB-O1	(3-1)	3%
	5-B(F)BB-2	(3-8)	2%

Use Example 18

55

[0186]

4O-BB(F,Me)TB(F,F)XNp(1F,3F)-F	(No. 118)	3%
--------------------------------	-----------	----

EP 3 299 439 B1

(continued)

5	1-BB-3	(2-8)	10%
	3-HH-V	(2-1)	25%
	3-BB(2F,3F)-O2	(9-3)	10%
	2-HH1OB(2F,3F)-O2	(10-5)	22%
10	3-HH1OB(2F,3F)-O2	(10-5)	15%
	3-HHB-1	(3-1)	8 %
	5-B(F)BB-2	(3-8)	7%

Use Example 19

[0187]

20	4S-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 120)	3 %
	3-HB-CL	(5-2)	5 %
	5-HB-CL	(5-2)	5 %
	3-HHB-OCF3	(6-1)	4%
25	3-H2HB-OCF3	(6-4)	3%
	5-H4HB-OCF3	(6-7)	13%
	V-HHB(F)-F	(6-2)	6%
	3-HHB(F)-F	(6-2)	6%
30	5-HHB(F)-F	(6-2)	6%
	3-H4HB(F,F)-CF3	(6-21)	7%
	5-H4HB(F,F)-CF3	(6-21)	8 %
	5-H2HB(F,F)-F	(6-15)	6%
35	5-H4HB(F,F)-F	(6-21)	8 %
	2-H2BB(F)-F	(6-26)	4%
	3-H2BB(F)-F	(6-26)	10%
40	3-HBEB(F,F)-F	(6-39)	6%

Use Example 20

[0188]

45	3-BB(2F,5Me)TB-O3	(No. 56)	3%
	1V2-BEB(F,F)-C	(8-15)	8 %
50	3-HB-C	(8-1)	15%
	2-BTB-1	(2-10)	8 %
	5-HH-VFF	(2-1)	26%
55	3-HHB-1	(3-1)	5%
	VFF-HHB-1	(3-1)	9%
	VFF2-HHB-1	(3-1)	13%

EP 3 299 439 B1

(continued)

5

3-H2BTB-2	(3-17)	4%
3-H2BTB-3	(3-17)	5%
3-H2BTB-4	(3-17)	4%

Use Example 21

10

[0189]

15

20

25

30

35

3-BB(F,Me)TB-4	(No. 49)	4 %
2-HH-3	(2-1)	14%
7-HB-1	(2-1)	8 %
5-HB-O2	(2-5)	10%
3-HB(2F,3F)-O2	(9-1)	12%
5-HB(2F,3F)-O2	(9-1)	16%
V-HHB(2F,3F)-O2	(10-1)	4%
V2-HHB(2F,3F)-O2	(10-1)	4%
5-HHB(2F,3CL)-O2	(10-12)	3%
2-H1OB(2F,3F)-O2	(9-5)	3 %
3-H1OB(2F,3F)-O2	(9-5)	3%
3-HH1OCro(7F,8F)-5	(13-6)	4%
5-HBB(F)B-2	(4-5)	7%
5-HBB(F)B-3	(4-5)	8 %

[0190] NI = 71.5°C; η = 23.3 mPa·s; Δn = 0.107; $\Delta \varepsilon$ = -2.8.

Use Example 22

[0191]

40

45

50

55

3-BB(F,Me)TB-03	(No. 50)	3%
2-HH-3	(2-1)	5%
3-HH-V1	(2-1)	8%
1V2-HH-1	(2-1)	8%
1V2-HH-3	(2-1)	8%
3-BB(2F,3F)-O2	(9-3)	7%
5-BB(2F,3F)-O2	(9-3)	5%
3-H1OB(2F,3 F)-O2	(9-5)	6%
2-HH1OB(2F,3F)-O2	(10-5)	7%
3-HH1OB(2F,3F)-O2	(10-5)	16%
3-HDhB(2F,3F)-O2	(10-3)	7%
2-HBB(2F,3F)-O2	(10-7)	3%
3-HBB(2F,3F)-O2	(10-7)	5%

(continued)

5	3-HHB-1	(3-1)	3%
	3-HHB-3	(3-1)	2%
	2-BB(2F,3F)B-3	(11-1)	7%

[0192] NI = 90.7°C; η = 23.4 mPa·s; Δn = 0.118; $\Delta \varepsilon$ = -4.4.

10 **Use Example 23**

[0193]

15	5-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 114)	7%
	3-GB(F)B(F,F)XB(F,F)-F	(7-57)	5%
	3-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
20	4-BB(F)B(F,F)XB(F,F)-F	(7-47)	7%
	5-BB(F)B(F,F)XB(F,F)-F	(7-47)	4%
	3-HH-V	(2-1)	35%
	3-HH-V1	(2-1)	5%
25	3-HHEH-5	(3-13)	3%
	3-HHB-1	(3-1)	4%
	V-HHB-1	(3-1)	5%
30	V2-BB(F)B-1	(3-6)	5%
	1V2-BB-F	(5-1)	3%
	3-BB(F,F)XB(F,F)-F	(6-97)	5%
35	3-GB(F,F)XB(F,F)-F	(6-113)	5%
	3-HHBB(F,F)-F	(7-6)	4%

[0194] NI = 86.4°C; η = 21.9 mPa·s; Δn = 0.120; $\Delta \varepsilon$ = 10.2.

40 **Use Example 24**

[0195]

45	40-BB(F,Me)TB(F,F)XB(F,F)-F	(No. 115)	3%
	3-GBB(F,F)XB(F,F)-F	(7)	5%
	4-GBB(F,F)XB(F,F)-F	(7)	5%
	5-GBB(F,F)XB(F,F)-F	(7)	4%
50	3-GB(F)B(F,F)XB(F,F)-F	(7-57)	4%
	3-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
	4-BB(F)B(F,F)XB(F,F)-F	(7-47)	4%
	5-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
55	3-HH-V	(2-1)	35%
	3-HH-V1	(2-1)	5%
	3-HHEH-5	(3-13)	3%

(continued)

5	3-HHB-1	(3-1)	4%
10	V-HHB-1	(3-1)	4%
	V2-BB(F)B-1	(3-6)	3 %
	1V2-BB-F	(5-1)	3%
	3-BB(F,F)XB(F,F)-F	(6-97)	5%
	3-GB(F,F)XB(F,F)-F	(6-113)	4%
	3-HHBB(F,F)-F	(7-6)	3%

Use Example 25**[0196]**

20	3-BB(F,Me)TB-S4	(No.1)	3%
25	2-HH-3	(2-1)	4%
	3-HH-V1	(2-1)	8%
	1V2-HH-1	(2-1)	7%
	1V2-HH-3	(2-1)	6%
30	V2-BB(2F,3F)-O2	(9-3)	6%
	5-BB(2F,3F)-O2	(9-3)	4%
	3-H1OB(2F,3F)-O2	(9-5)	8 %
	3-HchB(2F,3F)-O2	(-)	9%
	3-HH1OB(2F,3F)-O2	(10-5)	15%
	3-HDhB(2F,3F)-O2	(10-3)	6%
35	3-dhBB(2F,3F)-O2	(10-9)	3%
	V-HHB-1	(3-1)	4%
	V2-HHB-1	(3-1)	5%
	3-HHB-1	(3-1)	3%
40	3-HHB-3	(3-1)	2%
	2-BB(2F,3F)B-3	(11-1)	7%

Use Example 26**[0197]**

50	5-NpB(F,Me)TB-O3	(No. 54)	3%
55	5-HB(F)B(F,F)XB(F,F)-F	(7-41)	5%
	3-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
	4-BB(F)B(F,F)XB(F,F)-F	(7-47)	7%
	5-BB(F)B(F,F)XB(F,F)-F	(7-47)	3%
	3-HH-V	(2-1)	38%
	3-HH-V1	(2-1)	7%

(continued)

5	3-HHEH-5	(3-13)	3%
	3-HHB-1	(3-1)	4%
	V-HHB-1	(3-1)	5%
	V2-BB(F)B-1	(3-6)	5%
10	1V2-BB-F	(5-1)	3%
	3-BB(F,F)XB(F,F)-F	(6-97)	11%
	3-HHBB(F,F)-F	(7-6)	3%

Use Example 27**[0198]**

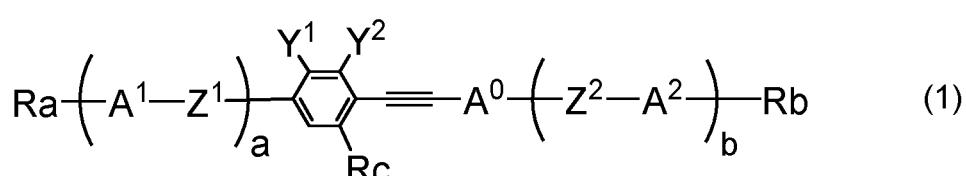
20	5-NpB(F,Me)TB(F,F)XB(F,F)-F	(No. 116)	4%
	2-HH-3	(2-1)	19%
	3-HH-4	(2-1)	8%
	1-BB-3	(2-8)	7%
25	3-HB-O2	(2-5)	5%
	3-BB(2F,3F)-O2	(9-3)	10%
	5-BB(2F,3F)-O2	(9-3)	7%
	2-HH1OB(2F,3F)-O2	(10-5)	11%
30	3-HH1OB(2F,3F)-O2	(10-5)	10%
	3-HBB(2F,3CL)-O2	(10-13)	3%
	5-HBB(2F,3CL)-O2	(10-13)	3%
35	3-HHB-1	(3-1)	3%
	3-HHB-01	(3-1)	3%
	5-B(F)BB-2	(3-8)	3%
	V-HBB-2	(3-4)	4%

Industrial Applicability

[0199] A liquid crystal compound of the invention has good physical properties. A liquid crystal composition containing the compound can be widely utilized to a liquid crystal display device used in a computer monitor, a television and so forth.

Claims

1. A compound, represented by formula (1):



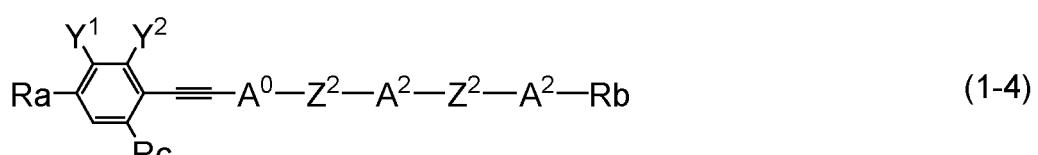
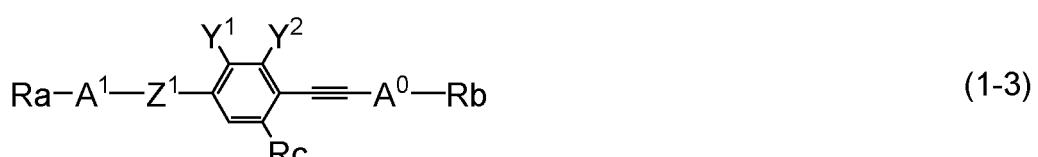
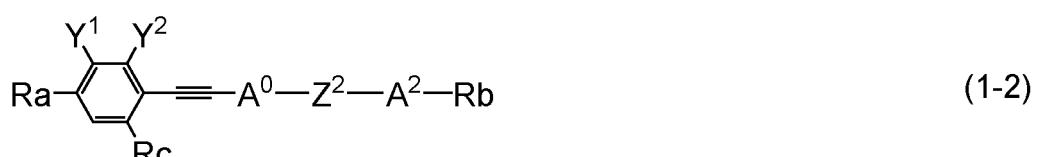
wherein, in formula (1), Ra and Rb are independently hydrogen, fluorine, chlorine, -CN, -SF₅, -C=C-SF₅ or alkyl

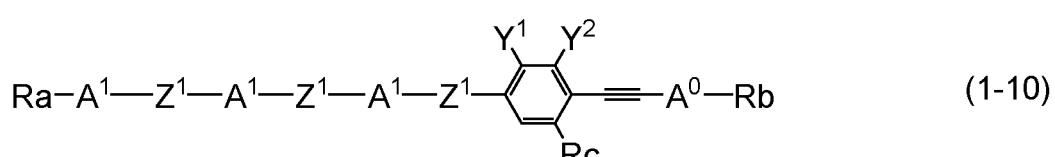
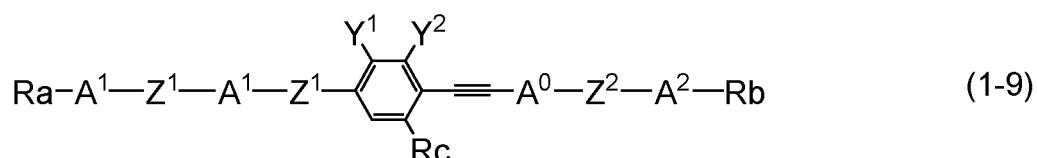
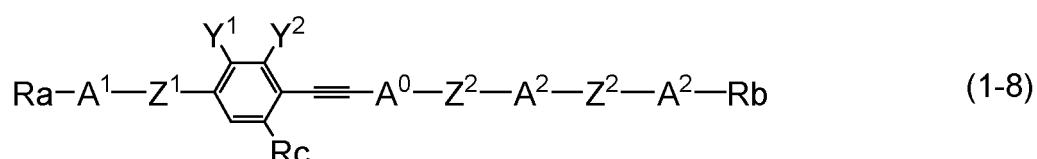
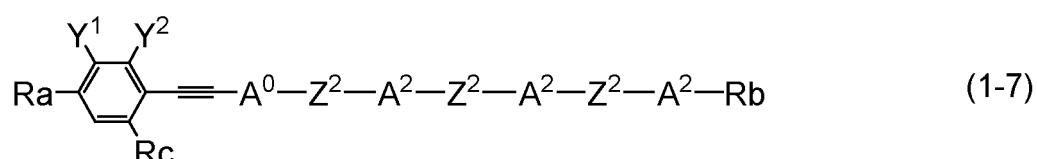
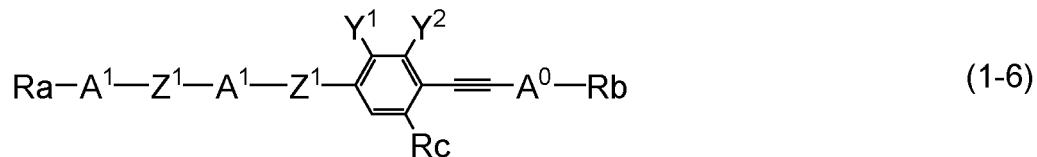
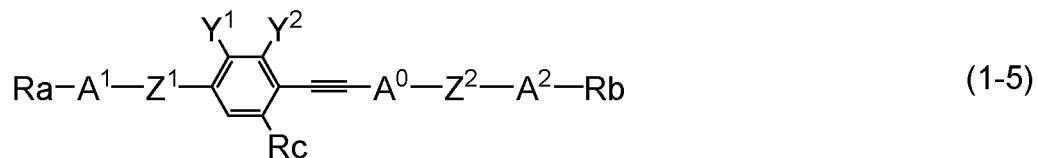
having 1 to 20 carbons, and in Ra and Rb, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$ or $-\text{SiH}_2-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$ or $-\text{C}=\text{C}-$, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine;

5 A^0 , A^1 and A^2 are independently 1,4-cyclohexylene, 1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-3,6-diyl, decahydronaphthalene-2,6-diyl, 1,2,3,4-tetrahydronaphthalene-2,6-diyl or naphthalene-2,6-diyl, and in A^0 , A^1 and A^2 , at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$ or $-\text{SiH}_2-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$, and in the groups, at least one hydrogen may be replaced by fluorine, chlorine, $-\text{CF}_3$, $-\text{CHF}_2$, $-\text{CH}_2\text{F}$, $-\text{OCF}_3$, $-\text{OCHF}_2$ or $-\text{OCH}_2\text{F}$; Z^1 and Z^2 are independently a single bond or alkylene having 1 to 4 carbons, and in Z^1 and Z^2 , at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$ or $-\text{SiH}_2-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; one of Y^1 and Y^2 is fluorine, and the other is hydrogen; Rc is alkyl having 1 to 4 carbons, and in Rc , at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, $-\text{S}-$, $-\text{CO}-$ or $-\text{SiH}_2-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$ or $-\text{C}=\text{C}-$; and a and b are independently 0, 1, 2 or 3, and a sum of a and b is 0, 1, 2 or 3.

15 2. The compound according to claim 1, wherein, in formula (1), Ra and Rb are independently fluorine, alkyl having 1 to 20 carbons, alkoxy having 1 to 19 carbons, alkoxyalkyl having 2 to 19 carbons, alkenyl having 2 to 20 carbons, fluoroalkyl having 1 to 20 carbons or fluoroalkoxy having 1 to 19 carbons; A^0 , A^1 and A^2 are independently 1,4-cyclohexylene, 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, pyridine-2,5-diyl, pyrimidine-2,5-diyl, pyridazine-3,6-diyl, naphthalene-2,6-diyl, 1-fluoronaphthalene-2,6-diyl, 1,3-difluoronaphthalene-2,6-diyl or 1,3,8-trifluoronaphthalene-2,6-diyl; Z^1 and Z^2 are independently a single bond, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CF}=\text{CF}-$, $-(\text{CH}_2)_2\text{CF}_2\text{O}-$ or $-\text{OCF}_2(\text{CH}_2)_2-$; one of Y^1 and Y^2 is fluorine, and the other is hydrogen; Rc is alkyl having 1 to 4 carbons or alkoxy having 1 to 3 carbons; and a and b are independently 0, 1, 2 or 3, and a sum of a and b is 0, 1 or 2.

25 3. The compound according to claim 1, represented by any one of formula (1-1) to formula (1-10):





wherein, in formula (1-1) to formula (1-10), Ra and Rb are independently hydrogen, fluorine, chlorine or alkyl having 1 to 10 carbons, and in Ra and Rb, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$ or $-\text{C}\equiv\text{C}-$, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; A^0 , A^1 and A^2 are independently 1,4-cyclohexylene, 1,4-phenylene, decahydronaphthalene-2,6-diyl, 1,2,3,4-tetrahydronaphthalene-2,6-diyl or naphthalene-2,6-diyl, and in the rings, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$, and in the rings, at least one hydrogen may be replaced by fluorine, chlorine, $-\text{CF}_3$, $-\text{CHF}_2$ or $-\text{CH}_2\text{F}$; Z^1 and Z^2 are independently a single bond or alkylene having 1 to 4 carbons, and in the alkylene, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$ or $-\text{CO}-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$, and in the groups, at least one hydrogen may be replaced by fluorine or chlorine; one of Y^1 and Y^2 is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons, and in the alkyl, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and at least one piece of $-\text{CH}_2\text{CH}_2-$ may be replaced by $-\text{CH}=\text{CH}-$ or $-\text{C}\equiv\text{C}-$.

50

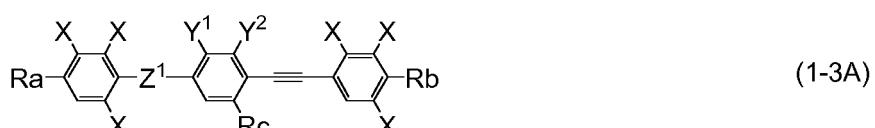
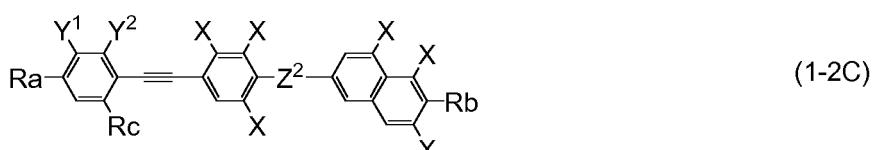
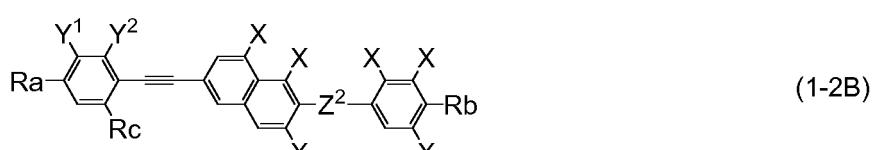
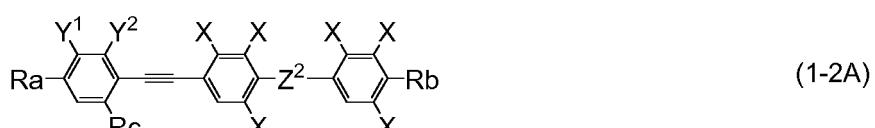
55

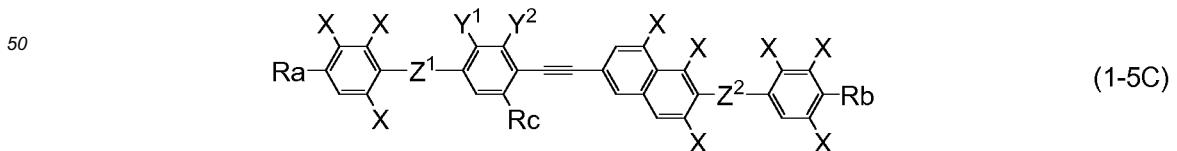
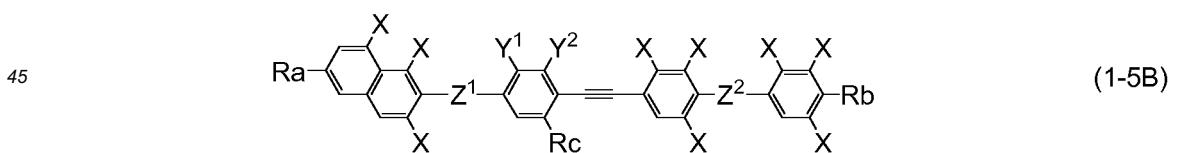
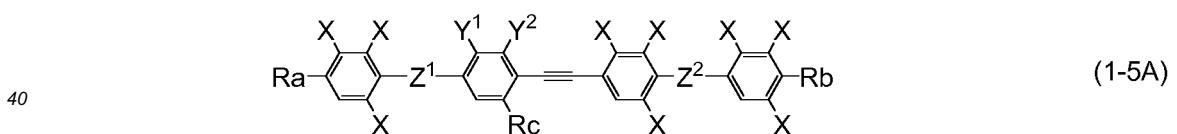
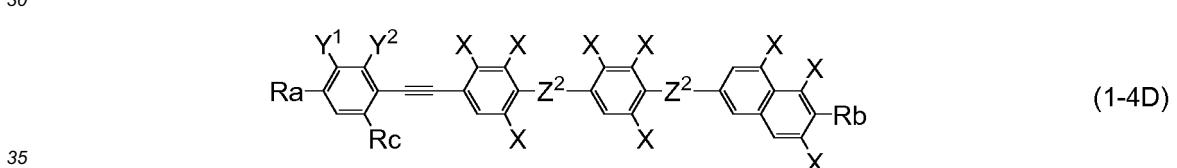
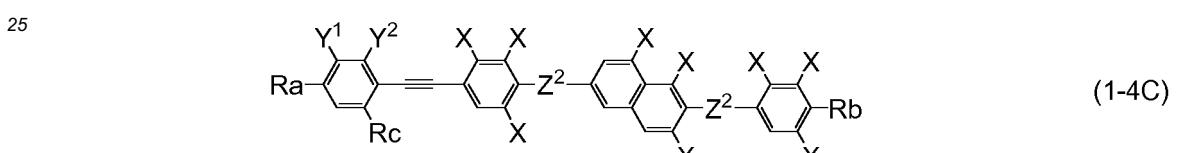
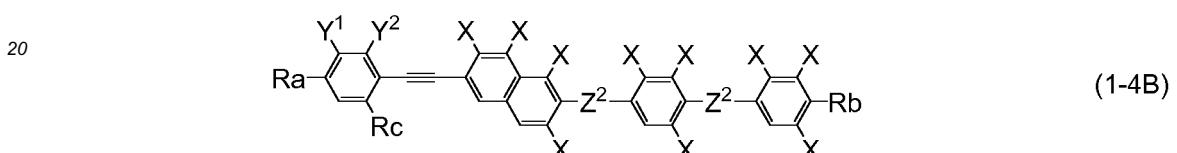
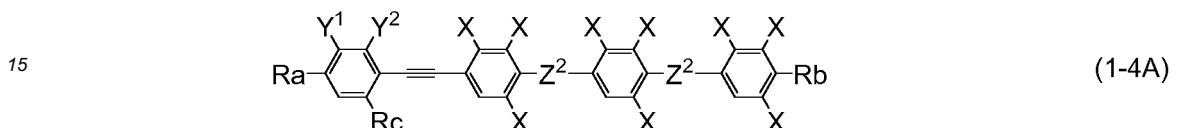
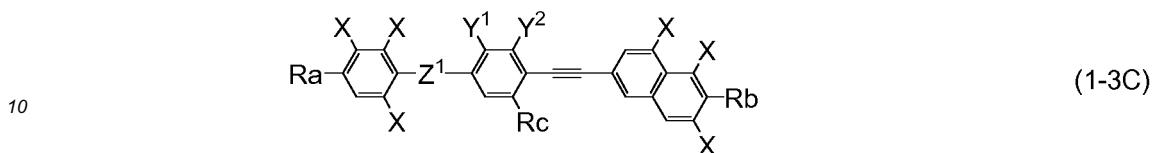
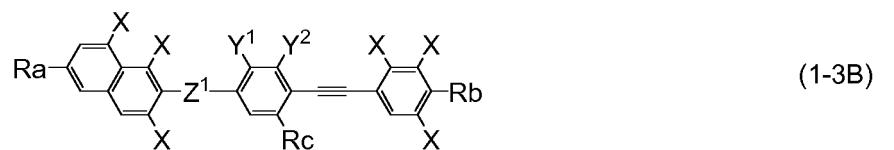
4. The compound according to claim 3, wherein, in formula (1-1) to formula (1-10), Ra and Rb are independently fluorine, alkyl having 1 to 10 carbons, alkoxy having 1 to 9 carbons, alkenyl having 2 to 10 carbons, fluoroalkyl

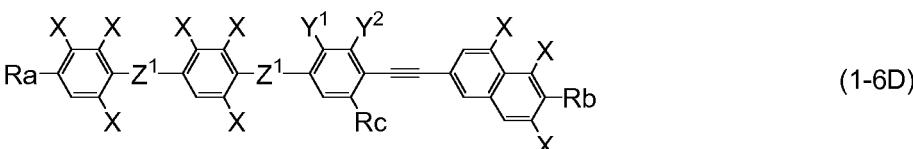
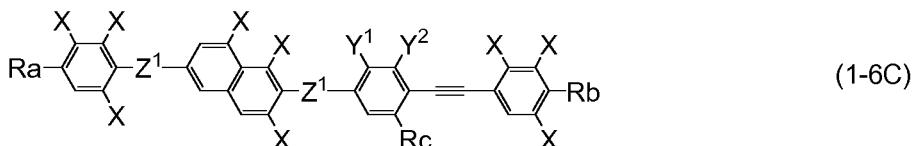
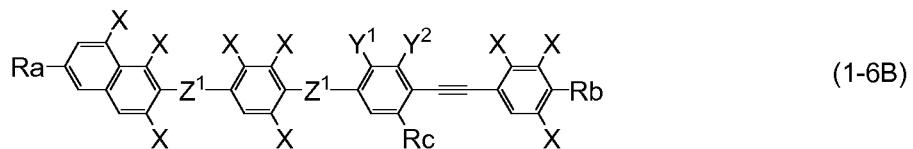
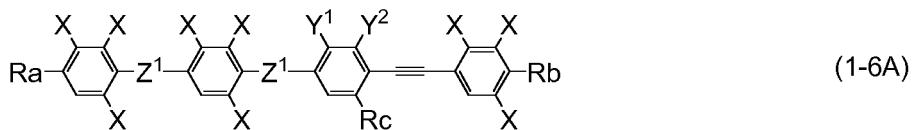
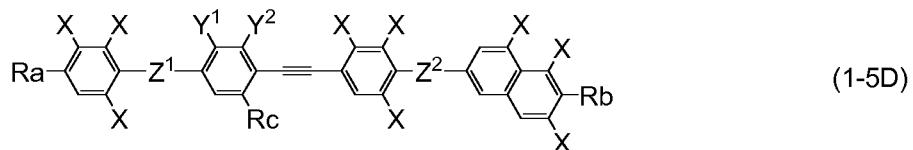
having 1 to 10 carbons or fluoroalkoxy having 2 to 10 carbons; A⁰, A¹ and A² are independently 1,3-dioxane-2,5-diyl, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene, 2,6-difluoro-1,4-phenylene, naphthalene-2,6-diyl, 1-fluoronaphthalene-2,6-diyl, 1,3-difluoronaphthalene-2,6-diyl or 1,3,8-trifluoronaphthalene-2,6-diyl; Z¹ and Z² are independently a single bond, -CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -(CH₂)₂CF₂O-, -OCF₂(CH₂)₂-, -(CH₂)₃O-, -O(CH₂)₃- or -(CH₂)₄-, one of Y¹ and Y² is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons, alkoxy having 1 to 4 carbons, alkoxyalkyl having 2 to 4 carbons or alkenyl having 2 to 4 carbons.

5. The compound according to claim 3, wherein, in formula (1-1) to formula (1-6), Ra and Rb are independently fluorine, alkyl having 1 to 8 carbons, alkoxy having 1 to 8 carbons or fluoroalkyl having 1 to 8 carbons; A⁰, A¹ and A² are independently 1,4-phenylene, 2-fluoro-1,4-phenylene or 2,6-difluoro-1,4-phenylene; Z¹ and Z² are independently a single bond, -CF₂O- or -OCF₂-, one of Y¹ and Y² is fluorine, and the other is hydrogen; and Rc is alkyl having 1 to 4 carbons.

10. 6. The compound according to claim 1, represented by any one of formula (1-1A) to formula (1-1B), formula (1-2A) to formula (1-2C), formula (1-3A) to formula (1-3C), formula (1-4A) to formula (1-4D), formula (1-5A) to formula (1-5D) and formula (1-6A) to formula (1-6D):







30 wherein, in formula (1-1A) to formula (1-1B), formula (1-2A) to formula (1-2C), formula (1-3A) to formula (1-3C), formula (1-4A) to formula (1-4D), formula (1-5A) to formula (1-5D) and formula (1-6A) to formula (1-6D), Ra and Rb are independently hydrogen, fluorine, $-CF_3$, $-CHF_2$, $-CH_2F$, $-OCF_3$, $-OCHF_2$, $-OCF_2CHF_2$, $-OCF_2CHFCF_3$ or alkyl having 1 to 10 carbons, and in the alkyl, at least one piece of $-CH_2-$ may be replaced by $-O-$, and at least one piece of $-CH_2CH_2-$ may be replaced by $-CH=CH-$; Z¹ and Z² are independently a single bond, $-CF_2O-$ or $-OCF_2-$; one of Y¹ and Y² is fluorine, and the other is hydrogen; Rc is methyl, ethyl or propyl; and X is hydrogen or fluorine.

35

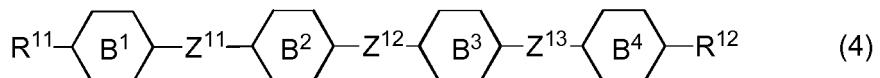
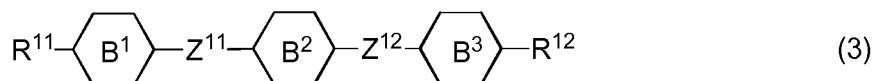
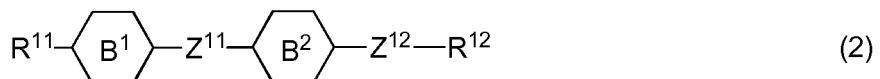
40

45

50

55

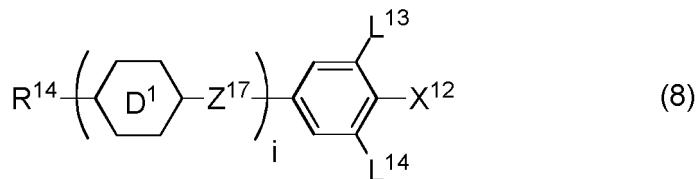
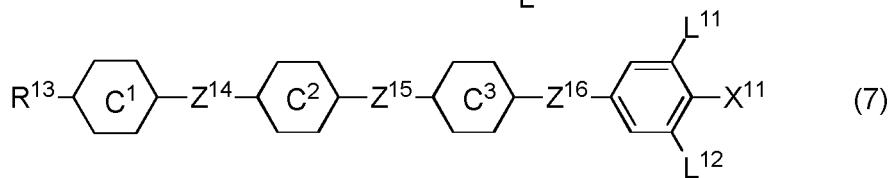
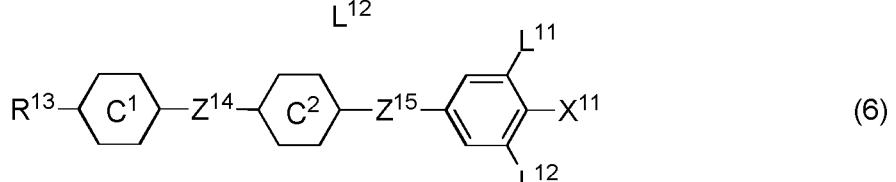
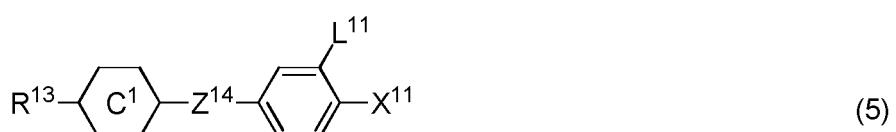
7. The compound according to claim 6, wherein, in formula (1-1A), formula (1-2A), formula (1-3A), formula (1-4A), formula (1-5A), formula (1-6A), formula (1-1B), formula (1-2B), formula (1-2C), formula (1-3B), formula (1-3C), formula (1-4B), formula (1-4C), formula (1-4D), formula (1-5B), formula (1-5C), formula (1-5D), formula (1-6B), formula (1-6C) or formula (1-6D), Ra and Rb are alkyl having 1 to 10 carbons or alkoxy having 1 to 10 carbons; Z¹ and Z² are a single bond; one of Y¹ and Y² is fluorine, and the other is hydrogen; Rc is methyl, ethyl or propyl; and X is hydrogen or fluorine.
8. The compound according to claim 6, wherein, in formula (1-1A), formula (1-2A), formula (1-3A), formula (1-4A), formula (1-5A), formula (1-6A), formula (1-1B), formula (1-2B), formula (1-2C), formula (1-3B), formula (1-3C), formula (1-4B), formula (1-4C), formula (1-4D), formula (1-5B), formula (1-5C), formula (1-5D), formula (1-6B), formula (1-6C) or formula (1-6D), one of Ra and Rb is fluorine, $-CF_3$ or $-OCF_3$, and the other is alkyl having 1 to 10 carbons or alkoxy having 1 to 10 carbons; Z¹ and Z² are a single bond, $-CF_2O-$ or $-OCF_2-$; Rc is methyl, ethyl or propyl; one of Y¹ and Y² is fluorine, and the other is hydrogen; and X is hydrogen or fluorine.
9. A liquid crystal composition, containing at least one compound according to claim 1.
10. The liquid crystal composition according to claim 9, further containing at least one compound selected from the group of compounds represented by formulas (2) to (4):



wherein, in formulas (2) to (4),

15 R^{11} and R^{12} are independently, alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in R^{11} and R^{12} , at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and in the groups, at least one hydrogen may be replaced by fluorine;
 ring B^1 , ring B^2 , ring B^3 and ring B^4 are independently 1,4-cyclohexylene, 1,4-phenylene, 2-fluoro-1,4-phenylene, 2,5-difluoro-1,4-phenylene or pyrimidine-2,5-diyl; and
 20 Z^{11} , Z^{12} and Z^{13} are independently a single bond, $-\text{COO}-$, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$ or $-\text{C}=\text{C}-$.

25 11. The liquid crystal composition according to claim 9, further containing at least one compound selected from the group of compounds represented by formulas (5) to (8):

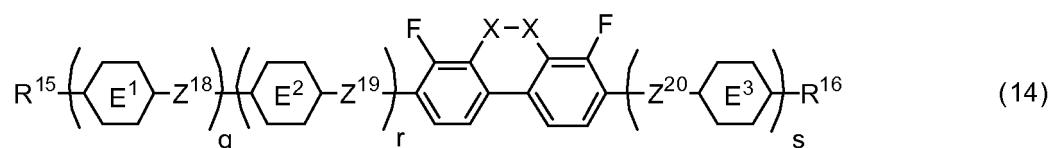
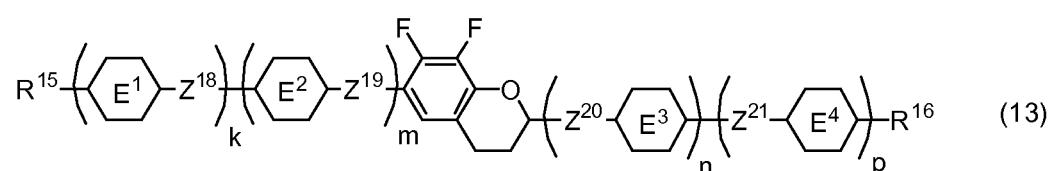
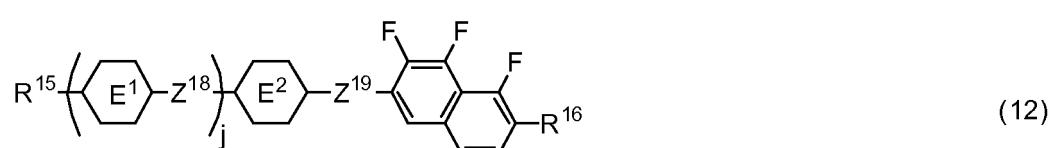
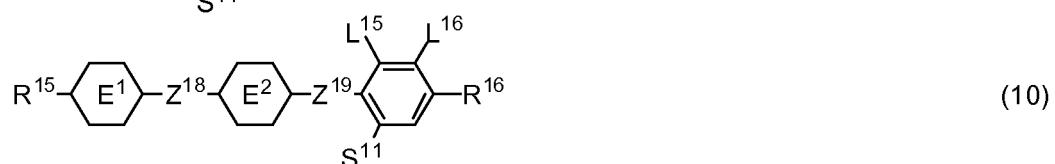


50 wherein, in formulas (5) to (7),

55 R^{13} is alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in the alkyl and the alkenyl, at least one piece of $-\text{CH}_2-$ may be replaced by $-\text{O}-$, and in the groups, at least one hydrogen may be replaced by fluorine; X^{11} is fluorine, chlorine, $-\text{OCF}_3$, $-\text{OCHF}_2$, $-\text{CF}_3$, $-\text{CHF}_2$, $-\text{CH}_2\text{F}$, $-\text{OCF}_2\text{CHF}_2$ or $-\text{OCF}_2\text{CHFCF}_3$; ring C^1 , ring C^2 and ring C^3 are independently 1,4-cyclohexylene, 1,4-phenylene, 1,4-phenylene in which at least one hydrogen is replaced by fluorine, tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl or pyrimidine-2,5-diyl; Z^{14} , Z^{15} and Z^{16} are independently a single bond, $-\text{COO}-$, $-\text{OCO}-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{C}=\text{C}-$ or $-(\text{CH}_2)_4-$;

L^{11} and L^{12} are independently hydrogen or fluorine; and wherein, in formula (8),
 R^{14} is alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in R^{14} , at least one piece of $-CH_2-$
 may be replaced by $-O-$, and in the groups, at least one hydrogen may be replaced by fluorine;
 X^{12} is $-C\equiv N$ or $-C\equiv C-C\equiv N$;
 5 ring D^1 is 1,4-cyclohexylene, 1,4-phenylene, 1,4-phenylene in which at least one hydrogen is replaced by
 fluorine, tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl or pyrimidine-2,5-diyl;
 Z^{17} is a single bond, $-COO-$, $-OCO-$, $-CH_2O-$, $-OCH_2-$, $-CF_2O-$, $-OCF_2-$, $-CH_2CH_2-$ or $-C\equiv C-$;
 L^{13} and L^{14} are independently hydrogen or fluorine; and
 10 i is 1, 2, 3 or 4.

10 12. The liquid crystal composition according to claim 9, further containing at least one compound selected from the group of compounds represented by formulas (9) to (15):



50 wherein, in formulas (9) to (15),

5 R¹⁵, R¹⁶ and R¹⁷ are independently alkyl having 1 to 10 carbons or alkenyl having 2 to 10 carbons, and in R¹⁵, R¹⁶ and R¹⁷, at least one piece of -CH₂- may be replaced by -O-, and in the groups, at least one hydrogen may be replaced by fluorine, in which R¹⁷ may be hydrogen or fluorine;

10 ring E¹, ring E², ring E³ and ring E⁴ are independently 1,4-cyclohexylene, 1,4-cyclohexenylene, 1,4-phenylene, 1,4-phenylene in which at least one hydrogen is replaced by fluorine, tetrahydropyran-2,5-diyl or decahydronaphthalene-2,6-diyl;

15 ring E⁵ and ring E⁶ are independently 1,4-cyclohexylene, 1,4-cyclohexenylene, 1,4-phenylene, tetrahydropyran-2,5-diyl or decahydronaphthalene-2,6-diyl;

20 Z¹⁸, Z¹⁹, Z²⁰ and Z²¹ are independently a single bond, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CF₂OCH₂CH₂- or -OCF₂CH₂CH₂-,

25 L¹⁵ and L¹⁶ are independently fluorine or chlorine;

 S¹¹ is hydrogen or methyl;

 X is -CHF- or -CF₂-; and

 j, k, m, n, p, q, r and s are independently 0 or 1, a sum of k, m, n and p is 1 or 2, a sum of q, r and s is 0, 1, 2 or 3, and t is 1, 2 or 3.

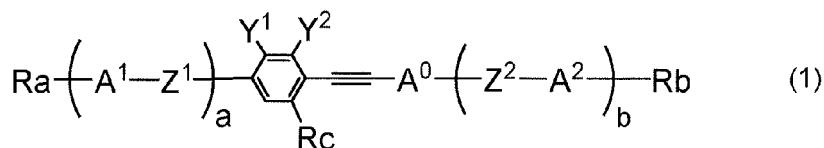
13. A liquid crystal display device, including the liquid crystal composition according to claim 9.

14. The liquid crystal display device according to claim 13, wherein the liquid crystal composition according to claim 9 is encapsulated.

15. The liquid crystal display device according to claim 13, wherein the liquid crystal composition according to claim 9 is used in a lens to be utilized in switching between 2D and 3D.

25 Patentansprüche

1. Verbindung, die durch Formel (1) wiedergegeben ist:



35 wobei in Formel (1) Ra und Rb unabhängig Wasserstoff, Fluor, Chlor, -CN, -SF₅, -C=C-SF₅ oder Alkyl mit 1 bis 20 Kohlenstoffen sind und in Ra und Rb mindestens ein -CH₂- durch -O-, -S-, -CO- oder -SiH₂- ersetzt sein kann und mindestens ein -CH₂CH₂- durch -CH=CH- oder -C=C- ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor oder Chlor ersetzt sein kann; A⁰, A¹ und A² unabhängig 1,4-Cyclohexylen, 1,4-Phenyl, Pyridin-2,5-diyl, Pyrimidin-2,5-diyl, Pyridazin-3,6-diyl, Decahydronaphthalin-2,6-diyl, 1,2,3,4-Tetrahydronaphthalin-2,6-diyl oder Naphthalin-2,6-diyl sind und in A⁰, A¹ und A² mindestens ein -CH₂- durch -O-, -S-, -CO- oder -SiH₂- ersetzt sein kann und mindestens ein -CH₂CH₂- durch -CH=CH- ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor, Chlor, -CF₃, -CHF₂, -CH₂F, -OCF₃, -OCHF₂ oder -OCH₂F ersetzt sein kann; Z¹ und Z² unabhängig eine Einfachbindung oder Alkylen mit 1 bis 4 Kohlenstoffen sind und in Z¹ und Z² mindestens ein -CH₂- durch -O-, -S-, -CO- oder -SiH₂- ersetzt sein kann und mindestens ein -CH₂CH₂- durch -CH=CH- ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor oder Chlor ersetzt sein kann; eines von Y¹ und Y² Fluor ist und das andere Wasserstoff ist; Rc Alkyl mit 1 bis 4 Kohlenstoffen ist und in Rc mindestens ein -CH₂- durch -O-, -S-, -CO- oder -SiH₂- ersetzt sein kann und mindestens ein -CH₂CH₂- durch -CH=CH- oder -C≡C-ersetzt sein kann; und

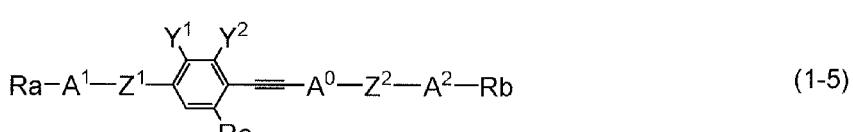
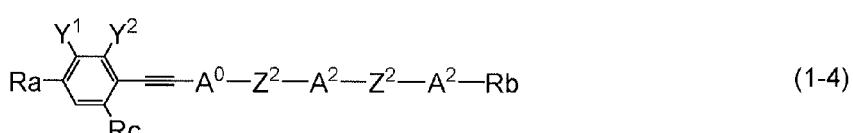
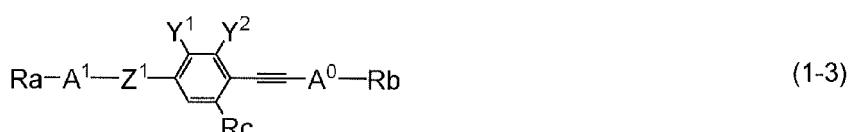
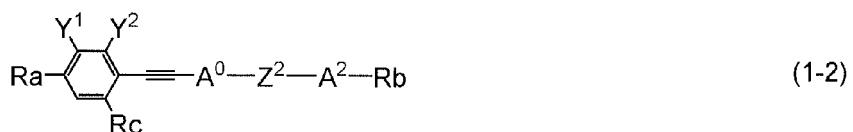
45 a und b unabhängig 0, 1, 2 oder 3 sind und eine Summe aus a und b = 0, 1, 2 oder 3 ist.

2. Verbindung gemäß Anspruch 1, wobei in Formel (1) Ra und Rb unabhängig Fluor, Alkyl mit 1 bis 20 Kohlenstoffen, Alkoxy mit 1 bis 19 Kohlenstoffen, Alkoxyalkyl mit 2 bis 19 Kohlenstoffen, Alkenyl mit 2 bis 20 Kohlenstoffen, Fluoralkyl mit 1 bis 20 Kohlenstoffen oder Fluoralkoxy mit 1 bis 19 Kohlenstoffen sind; A⁰, A¹ und A² unabhängig 1,4-Cyclohexylen, 1,3-Dioxan-2,5-diyl, 1,4-Phenyl, 2-Fluor-1,4-phenyl, 2,6-Difluor-1,4-phenyl, Pyridin-2,5-diyl, Pyrimidin-2,5-diyl, Pyridazin-3,6-diyl, Naphthalin-2,6-diyl, 1-Fluornaphthalin-2,6-diyl, 1,3-Difluornaphthalin-2,6-diyl oder 1,3,8-Trifluornaphthalin-2,6-diyl sind; Z¹ und Z² unabhängig eine Einfachbindung, -CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -(CH₂)₂CF₂O- oder -OCF₂(CH₂)₂- sind; eines von Y¹ und Y² Fluor ist und das

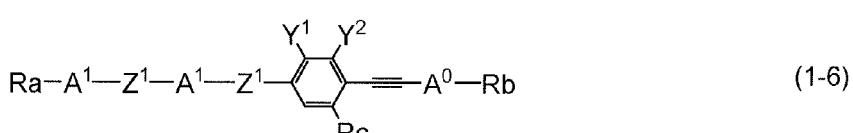
andere Wasserstoff ist; Rc Alkyl mit 1 bis 4 Kohlenstoffen oder Alkoxy mit 1 bis 3 Kohlenstoffen ist und a und b unabhängig 0, 1, 2 oder 3 sind und eine Summe aus a und b = 0, 1 oder 2 ist.

3. Verbindung gemäß Anspruch 1, die durch eine der Formeln (1-1) bis (1-10) wiedergegeben ist:

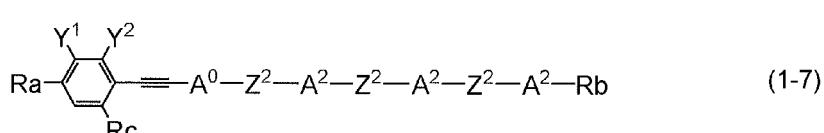
5



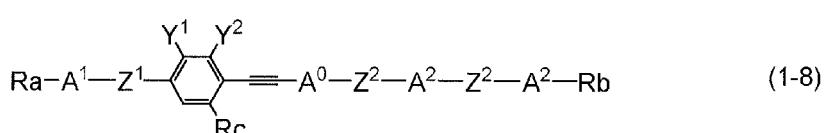
35



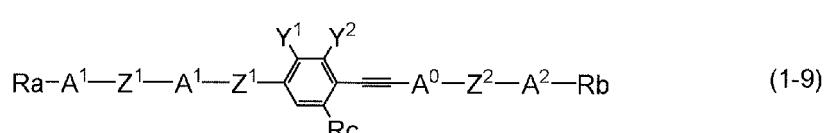
45

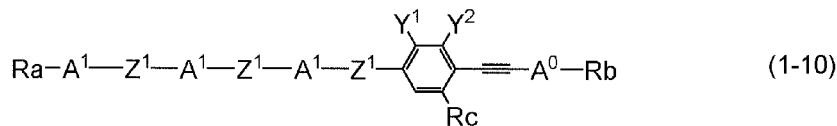


50



55





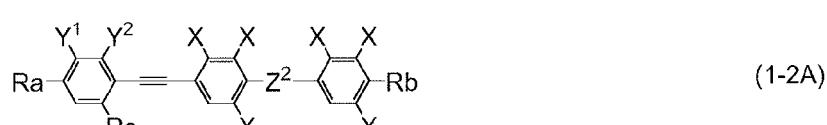
wobei in Formel (1-1) bis Formel (1-10) Ra und Rb unabhängig Wasserstoff, Fluor, Chlor oder Alkyl mit 1 bis 10 Kohlenstoffen sind und in Ra und Rb mindestens ein $-\text{CH}_2-$ durch $-\text{O}-$ ersetzt sein kann und mindestens ein $-\text{CH}_2\text{CH}_2-$ durch $-\text{CH}=\text{CH}-$ oder $-\text{C}\equiv\text{C}-$ ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor oder Chlor ersetzt sein kann; A^0 , A^1 und A^2 unabhängig 1,4-Cyclohexylen, 1,4-Phenylen, Decahydronaphthalin-2,6-diyl, 1,2,3,4-Tetrahydronaphthalin-2,6-diyl oder Naphthalin-2,6-diyl sind und in den Ringen mindestens ein $-\text{CH}_2-$ durch $-\text{O}-$ ersetzt sein kann und mindestens ein $-\text{CH}_2\text{CH}_2-$ durch $-\text{CH}=\text{CH}-$ ersetzt sein kann und in den Ringen mindestens ein Wasserstoff durch Fluor, Chlor, $-\text{CF}_3$, $-\text{CHF}_2$ oder $-\text{CH}_2\text{F}$ ersetzt sein kann; Z^1 und Z^2 unabhängig eine Einfachbindung oder Alkylen mit 1 bis 4 Kohlenstoffen sind und in dem Alkylen mindestens ein $-\text{CH}_2-$ durch $-\text{O}-$ oder $-\text{CO}-$ ersetzt sein kann und mindestens ein $-\text{CH}_2\text{CH}_2-$ durch $-\text{CH}=\text{CH}-$ ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor oder Chlor ersetzt sein kann; eines von Y^1 und Y^2 Fluor ist und das andere Wasserstoff ist und Rc Alkyl mit 1 bis 4 Kohlenstoffen ist und in dem Alkyl mindestens ein $-\text{CH}_2-$ durch $-\text{O}-$ ersetzt sein kann und mindestens ein $-\text{CH}_2\text{CH}_2-$ durch $-\text{CH}=\text{CH}-$ oder $-\text{C}\equiv\text{C}-$ ersetzt sein kann.

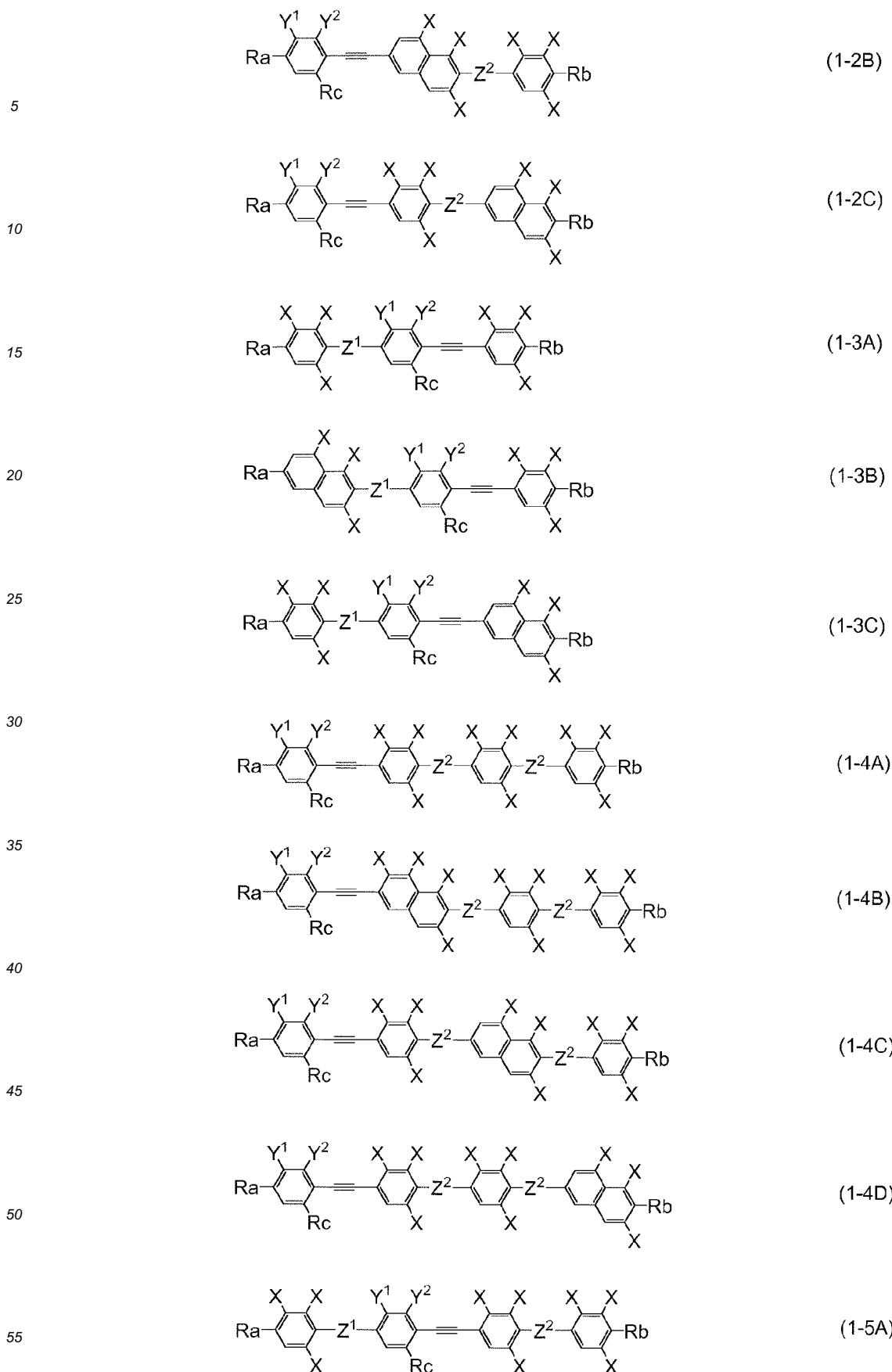
15

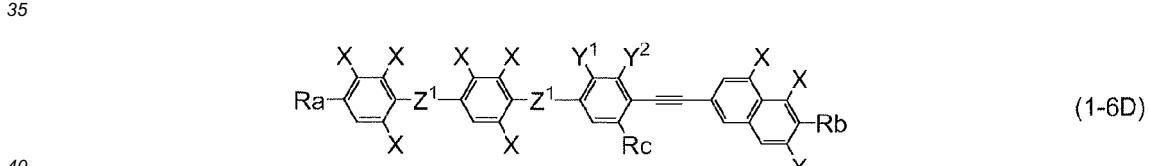
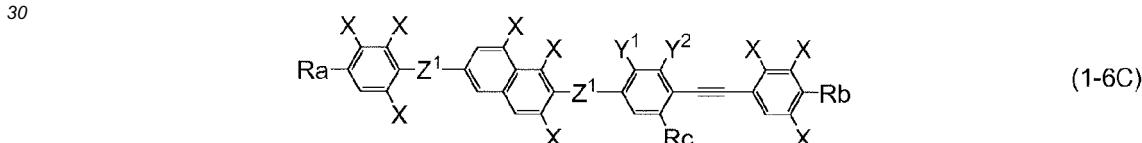
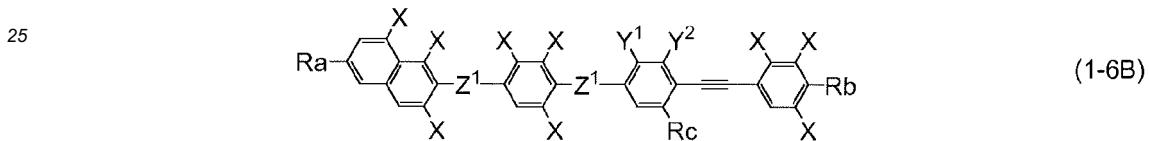
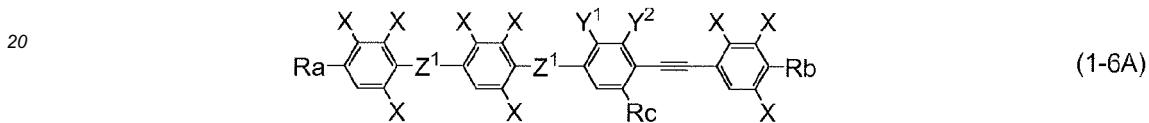
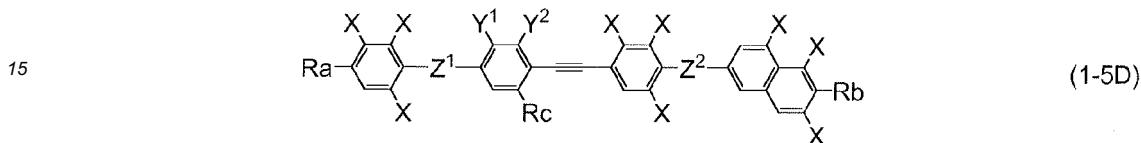
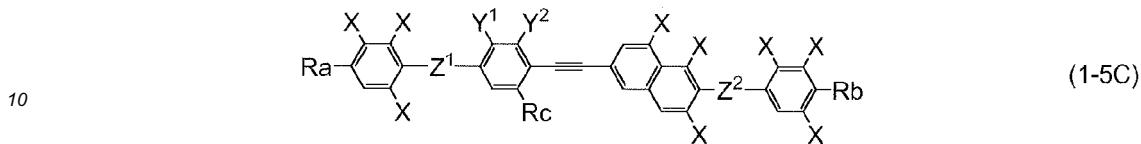
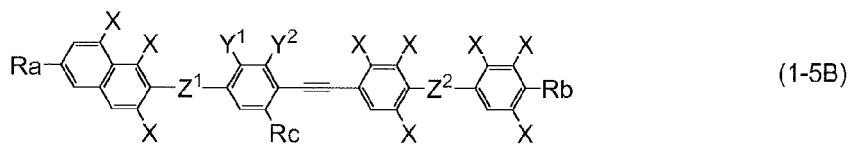
20 4. Verbindung gemäß Anspruch 3, wobei in Formel (1-1) bis Formel (1-10) Ra und Rb unabhängig Fluor, Alkyl mit 1 bis 10 Kohlenstoffen, Alkoxy mit 1 bis 9 Kohlenstoffen, Alkenyl mit 2 bis 10 Kohlenstoffen, Fluoralkyl mit 1 bis 10 Kohlenstoffen oder Fluoralkoxy mit 2 bis 10 Kohlenstoffen sind; A^0 , A^1 und A^2 unabhängig 1,3-Dioxan-2,5-diyl, 1,4-Phenylen, 2-Fluor-1,4-phenylen, 2,5-Difluor-1,4-phenylen, 2,6-Difluor-1,4-phenylen, Naphthalin-2,6-diyl, 1-Fluor-naphthalin-2,6-diyl, 1,3-Difluornaphthalin-2,6-diyl oder 1,3,8-Trifluornaphthalin-2,6-diyl sind; Z^1 und Z^2 unabhängig eine Einfachbindung, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}_2\text{O}-$, $-\text{OCH}_2-$, $-\text{CF}_2\text{O}-$, $-\text{OCF}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CF}=\text{CF}-$, $-\text{(CH}_2)_2\text{CF}_2\text{O}-$, $-\text{OCF}_2(\text{CH}_2)_2-$, $-(\text{CH}_2)_3\text{O}-$, $-\text{O}(\text{CH}_2)_3-$ oder $-(\text{CH}_2)_4-$ sind; eines von Y^1 und Y^2 Fluor ist und das andere Wasserstoff ist und Rc Alkyl mit 1 bis 4 Kohlenstoffen, Alkoxy mit 1 bis 4 Kohlenstoffen, Alkoxyalkyl mit 2 bis 4 Kohlenstoffen oder Alkenyl mit 2 bis 4 Kohlenstoffen ist.

25 5. Verbindung gemäß Anspruch 3, wobei in Formel (1-1) bis Formel (1-6) Ra und Rb unabhängig Fluor, Alkyl mit 1 bis 8 Kohlenstoffen, Alkoxy mit 1 bis 8 Kohlenstoffen oder Fluoralkyl mit 1 bis 8 Kohlenstoffen sind; A^0 , A^1 und A^2 unabhängig 1,4-Phenylen, 2-Fluor-1,4-phenylen oder 2,6-difluor-1,4-phenylen sind; Z^1 und Z^2 unabhängig eine Einfachbindung, $-\text{CF}_2\text{O}-$ oder $-\text{OCF}_2-$ sind; eines von Y^1 und Y^2 Fluor ist und das andere Wasserstoff ist und Rc Alkyl mit 1 bis 4 Kohlenstoffen ist.

30 35 6. Verbindung gemäß Anspruch 1, die durch eine der Formeln (1-1A) bis (1-1B), der Formeln (1-2A) bis (1-2C), der Formeln (1-3A) bis (1-3C), der Formeln (1-4A) bis (1-4D), der Formeln (1-5A) bis (1-5D) und der Formeln (1-6A) bis (1-6D) wiedergegeben ist:







wobei in Formel (1-1A) bis Formel (1-1B), Formel (1-2A) bis Formel (1-2C), Formel (1-3A) bis Formel (1-3C), Formel (1-4A) bis Formel (1-4D), Formel (1-5A) bis Formel (1-5D) und Formel (1-6A) bis Formel (1-6D) Ra und Rb unabhängig Wasserstoff, Fluor, -CF₃, -CHF₂, -CH₂F, -OCF₃, -OCHF₂, -OCF₂CHF₂, -OCF₂CHFCF₃ oder Alkyl mit 1 bis 10 Kohlenstoffen sind und in dem Alkyl mindestens ein -CH₂- durch -O- ersetzt sein kann und mindestens ein -CH₂CH₂- durch -CH=CH- ersetzt sein kann; Z¹ und Z² unabhängig eine Einfachbindung, -CF₂O- oder -OCF₂- sind; eines von Y¹ und Y² Fluor ist und das andere Wasserstoff ist; Rc Methyl, Ethyl oder Propyl ist und X Wasserstoff oder Fluor ist.

45

50

55

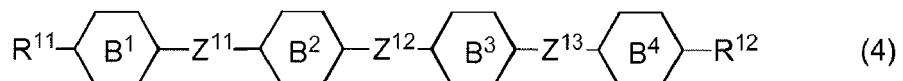
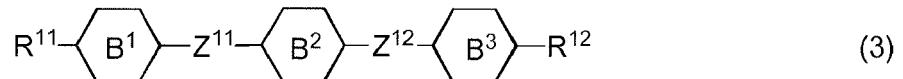
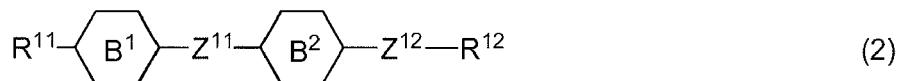
7. Verbindung gemäß Anspruch 6, wobei in Formel (1-1A), Formel (1-2A), Formel (1-3A), Formel (1-4A), Formel (1-5A), Formel (1-6A), Formel (1-1B), Formel (1-2B), Formel (1-2C), Formel (1-3B), Formel (1-3C), Formel (1-4B), Formel (1-4C), Formel (1-4D), Formel (1-5B), Formel (1-5C), Formel (1-5D), Formel (1-6B), Formel (1-6C) oder Formel (1-6D) Ra und Rb Alkyl mit 1 bis 10 Kohlenstoffen oder Alkoxy mit 1 bis 10 Kohlenstoffen sind; Z¹ und Z² eine Einfachbindung sind; eines von Y¹ und Y² Fluor ist und das andere Wasserstoff ist; Rc Methyl, Ethyl oder Propyl ist und X Wasserstoff oder Fluor ist.

8. Verbindung gemäß Anspruch 6, wobei in Formel (1-1A), Formel (1-2A), Formel (1-3A), Formel (1-4A), Formel (1-5A), Formel (1-6A), Formel (1-1B), Formel (1-2B), Formel (1-2C), Formel (1-3B), Formel (1-3C), Formel (1-4B), Formel (1-4C), Formel (1-4D), Formel (1-5B), Formel (1-5C), Formel (1-5D), Formel (1-6B), Formel (1-6C) oder Formel

(1-6D) eines von Ra und Rb Fluor, $-\text{CF}_3$ oder $-\text{OCF}_3$ ist und das andere Alkyl mit 1 bis 10 Kohlenstoffen oder Alkoxy mit 1 bis 10 Kohlenstoffen ist; Z^1 und Z^2 eine Einfachbindung, $-\text{CF}_2\text{O}-$ oder $-\text{OCF}_2-$ sind; R_c Methyl, Ethyl oder Propyl ist; eines von Y^1 und Y^2 Fluor ist und das andere Wasserstoff ist und X Wasserstoff oder Fluor ist.

5 9. Flüssigkristallzusammensetzung, die mindestens eine Verbindung gemäß Anspruch 1 enthält.

10. Flüssigkristallzusammensetzung gemäß Anspruch 9, die ferner mindestens eine Verbindung enthält, welche aus der Gruppe von durch die Formeln (2) bis (4) wiedergegebenen Verbindungen ausgewählt ist:

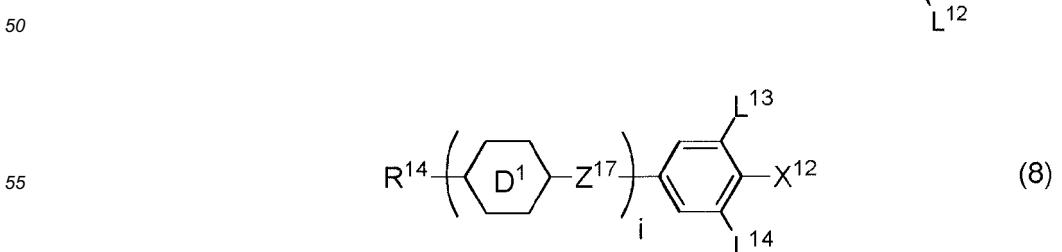
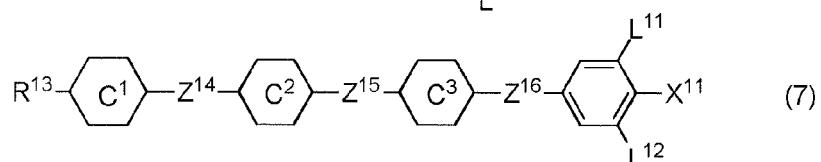
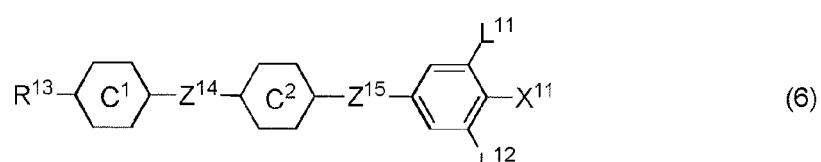
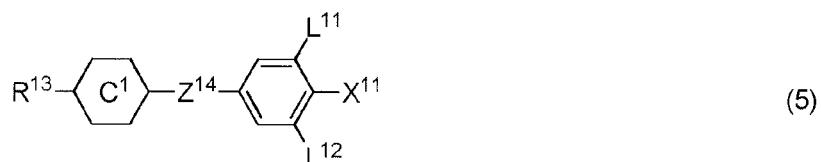


wobei in den Formeln (2) bis (4)

R^{11} und R^{12} unabhängig Alkyl mit 1 bis 10 Kohlenstoffen oder Alkenyl mit 2 bis 10 Kohlenstoffen sind und in R^{11} und R^{12} mindestens ein $-\text{CH}_2-$ durch $-\text{O}-$ ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor ersetzt sein kann;

25 Ring B¹, Ring B², Ring B³ und Ring B⁴ unabhängig 1,4-Cyclohexylen, 1,4-Phenylen, 2-Fluor-1,4-phenylen, 2,5-Difluor-1,4-phenylen oder Pyrimidin-2,5-diyi sind und
 Z^{11} , Z^{12} und Z^{13} unabhängig eine Einfachbindung, $-\text{COO}-$, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$ oder $-\text{C}\equiv\text{Cs}$ sind.

30 11. Flüssigkristallzusammensetzung gemäß Anspruch 9, die ferner mindestens eine Verbindung enthält, welche aus der Gruppe von durch die Formeln (5) bis (8) wiedergegebenen Verbindungen ausgewählt ist:



wobei in den Formeln (5) bis (7)

R¹³ Alkyl mit 1 bis 10 Kohlenstoffen oder Alkenyl mit 2 bis 10 Kohlenstoffen ist und in dem Alkyl und dem Alkenyl mindestens ein -CH₂- durch -O- ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor ersetzt sein kann;

X¹¹ Fluor, Chlor, -OCF₃, -OCHF₂, -CF₃, -CHF₂, -CH₂F, -OCF₂CHF₂ oder -OCF₂CHFCF₃ ist;

Ring C¹, Ring C² und Ring C³ unabhängig 1,4-Cyclohexylen, 1,4-Phenylen, 1,4-Phenylen, in dem mindestens ein Wasserstoff durch Fluor ersetzt ist, Tetrahydropyran-2,5-diyl, 1,3-Dioxan-2,5-diyl oder Pyrimidin-2,5-diyl sind;

Z¹⁴, Z¹⁵ und Z¹⁶ unabhängig eine Einfachbindung, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CH=CH-, -C≡C- oder -(CH₂)₄- sind;

L¹¹ und L¹² unabhängig Wasserstoff oder Fluor sind; und wobei in Formel (8)

R¹⁴ Alkyl mit 1 bis 10 Kohlenstoffen oder Alkenyl mit 2 bis 10 Kohlenstoffen ist und in R¹⁴ mindestens ein -CH₂- durch -O- ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor ersetzt sein kann; X¹² -C≡N oder -C≡C-C≡N ist;

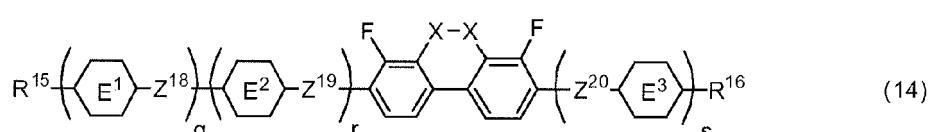
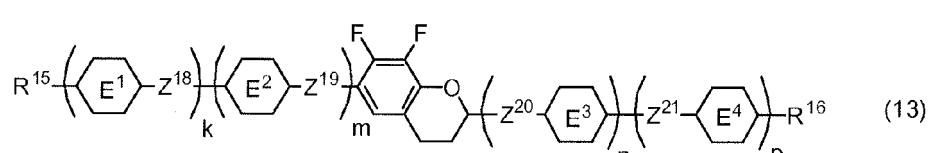
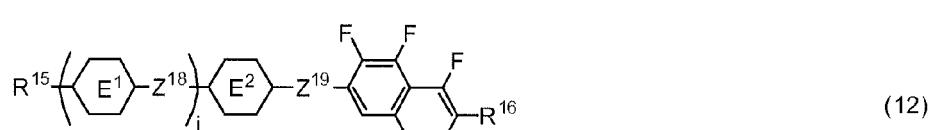
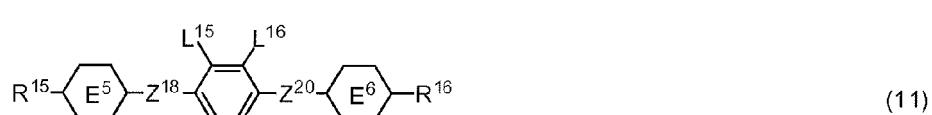
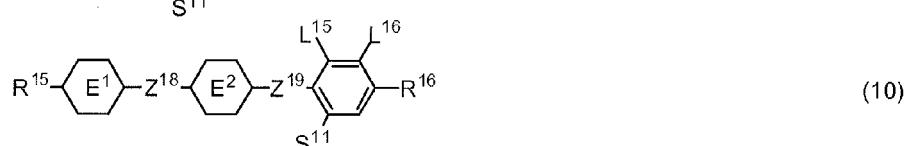
Ring D¹ 1,4-Cyclohexylen, 1,4-Phenylen, 1,4-Phenylen, in dem mindestens ein Wasserstoff durch Fluor ersetzt ist, Tetrahydropyran-2,5-diyl, 1,3-Dioxan-2,5-diyl oder Pyrimidin-2,5-diyl ist;

Z¹⁷ eine Einfachbindung, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂- oder -C≡O ist;

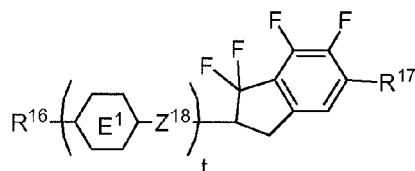
L¹³ und L¹⁴ unabhängig Wasserstoff oder Fluor sind und

i = 1, 2, 3 oder 4 ist.

12. Flüssigkristallzusammensetzung gemäß Anspruch 9, die ferner mindestens eine Verbindung enthält, welche aus der Gruppe von durch die Formeln (9) bis (15) wiedergegebenen Verbindungen ausgewählt ist:



(15)



wobei in den Formeln (9) bis (15)

R^{15} , R^{16} und R^{17} unabhängig Alkyl mit 1 bis 10 Kohlenstoffen oder Alkenyl mit 2 bis 10 Kohlenstoffen sind und in R^{15} , R^{16} und R^{17} mindestens ein $-CH_2-$ durch $-O-$ ersetzt sein kann und in den Gruppen mindestens ein Wasserstoff durch Fluor ersetzt sein kann, wobei R^{17} Wasserstoff oder Fluor sein kann;

Ring E^1 , Ring E^2 , Ring E^3 und Ring E^4 unabhängig 1,4-Cyclohexylen, 1,4-Cyclohexenylen, 1,4-Phenylen, 1,4-Phenylen, in dem mindestens ein Wasserstoff durch Fluor ersetzt ist, Tetrahydropyran-2,5-diyl oder Decahydronaphthalin-2,6-diyl sind;

Ring E^5 und Ring E^6 unabhängig 1,4-Cyclohexylen, 1,4-Cyclohexenylen, 1,4-Phenylen, Tetrahydropyran-2,5-diyl oder Decahydronaphthalin-2,6-diyl sind;

Z^{18} , Z^{19} , Z^{20} und Z^{21} unabhängig eine Einfachbindung, $-COO-$, $-OCO-$, $-CH_2O-$, $-OCH_2-$, $-CF_2O-$, $-OCF_2-$, $-CH_2CH_2-$, $-CF_2OCH_2CH_2-$ oder $-OCF_2CH_2CH_2-$ sind;

L^{15} und L^{16} unabhängig Fluor oder Chlor sind;

S^{11} Wasserstoff oder Methyl ist;

X $-CHF-$ oder $-CF_2-$ ist und

j , k , m , n , p , q , r und s unabhängig 0 oder 1 sind, eine Summe aus k , m , n und p = 1 oder 2 ist, eine Summe aus q , r und s = 0, 1, 2 oder 3 ist und t = 1, 2 oder 3 ist.

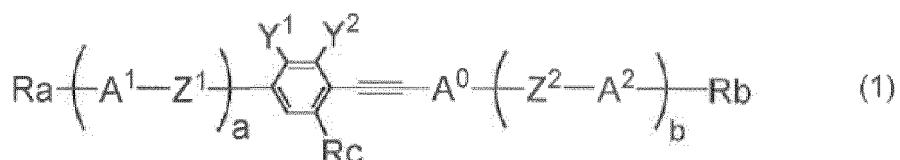
25 13. Flüssigkristallanzeigevorrichtung, die die Flüssigkristallzusammensetzung gemäß Anspruch 9 aufweist.

14. Flüssigkristallanzeigevorrichtung gemäß Anspruch 13, wobei die Flüssigkristallzusammensetzung gemäß Anspruch 9 eingekapselt ist.

30 15. Flüssigkristallanzeigevorrichtung gemäß Anspruch 13, wobei die Flüssigkristallzusammensetzung gemäß Anspruch 9 in einer Linse zur Nutzung beim Umschalten zwischen 2D und 3D verwendet wird.

Revendications

35 1. Composé représenté par la formule (1) :



40 dans lequel, dans la formule (1), Ra et Rb sont de façon indépendante l'hydrogène, le fluor, le chlore, $-CN$, $-SF_5$, $-C\equiv C-SF_5$ ou un alkyle ayant de 1 à 20 carbones et dans Ra et Rb , au moins un $-CH_2-$ peut être remplacé par $-O-$, $-S-$, $-CO-$ ou $-SiH_2-$, et au moins un $-CH_2CH_2-$ peut être remplacé par $-CH=CH-$ ou $-C\equiv C-$, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor ou le chlore ; A^0 , A^1 et A^2 sont de façon indépendante le 1,4-cyclohexylène, le 1,4-phénylène, la pyridine-2,5-diyl, la pyrimidine-2,5-diyl, la pyridazine-3,6-diyl, le décahydronaphthalène-2,6-diyl, le 1,2,3,4-tétrahydronaphthalène-2,6-diyl ou le naphtalène-2,6-diyl, et dans A^0 , A^1 et A^2 , au moins un $-CH_2-$ peut être remplacé par $-O-$, $-S-$, $-CO-$ ou $-SiH_2-$, et au moins un $-CH_2CH_2-$ peut être remplacé par $-CH=CH-$, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor, le chlore, $-CF_3$, $-CHF_2$, $-CH_2F$, $-OCF_3$, $-OCHF_2$ ou $-OCH_2F$; Z^1 et Z^2 sont de façon indépendante une liaison unique ou un alkylène ayant de 1 à 4 carbones et dans Z^1 et Z^2 , au moins un $-CH_2-$ peut être remplacé par $-O-$, $-S-$, $-CO-$ ou $-SiH_2-$, et au moins un $-CH_2CH_2-$ peut être remplacé par $-CH=CH-$, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor ou le chlore ; un de Y^1 et Y^2 est le fluor, et l'autre est l'hydrogène ; Rc est un alkyle ayant de 1 à 4 carbones et dans Rc , au moins un $-CH_2-$ peut être remplacé par $-O-$, $-S-$, $-CO-$ ou $-SiH_2-$, et au moins un $-CH_2CH_2-$ peut être remplacé par $-CH=CH-$ ou $-C\equiv C-$; et

a et b sont de façon indépendante 0, 1, 2 ou 3, et une somme de a et b est 0, 1, 2 ou 3.

2. Composé selon la revendication 1, dans lequel, dans la formule (1), Ra et Rb sont de façon indépendante le fluor, un alkyle ayant de 1 à 20 carbones, un alkoxy ayant de 1 à 19 carbones, un alkoxyalkyle ayant de 2 à 19 carbones, un alkényle ayant de 2 à 20 carbones, un fluoroalkyle ayant de 1 à 20 carbones ou un fluoroalkoxy ayant de 1 à 19 carbones ; A⁰, A¹ et A² sont de façon indépendante le 1,4-cyclohexylène, le 1,3-dioxane-2,5-diyl, le 1,4-phénylène, le 2-fluoro-1,4-phénylène, le 2,6-difluoro-1,4-phénylène, la pyridine-2,5-diyl, la pyrimidine-2,5-diyl, la pyridazine-3,6-diyl, le naphtalène-2,6-diyl, le 1-fluoronaphtalène-2,6-diyl, le 1,3-difluoronaphtalène-2,6-diyl, le 1,3,8-trifluoronaphtalène-2,6-diyl ; Z¹ et Z² sont de façon indépendante une liaison unique, -CH₂CH₂-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH=CH-, -CF=CF-, -(CH₂)₂CF₂O- ou -OCF₂(CH₂)₂- ; un de Y¹ et Y² est le fluor, et l'autre est l'hydrogène ; Rc est un alkyle ayant de 1 à 4 carbones ou un alkoxy ayant de 1 à 3 carbones ; et a et b sont de façon indépendante 0, 1, 2 ou 3, et une somme de a et b est 0, 1 ou 2.

3. Composé selon la revendication 1, représenté par l'une quelconque des formules (1-1) à (1-10) :

15



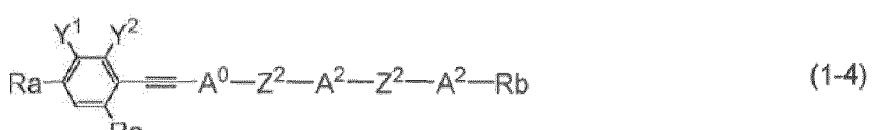
20



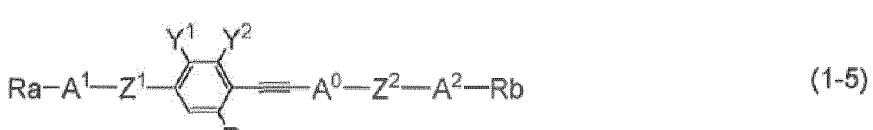
25



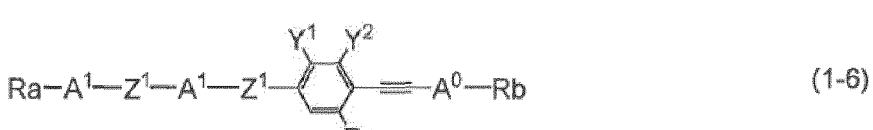
30



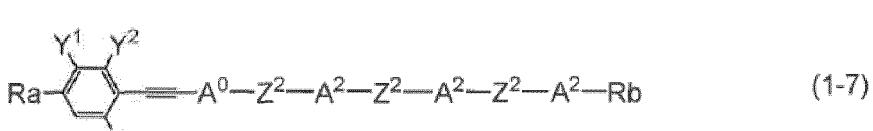
35



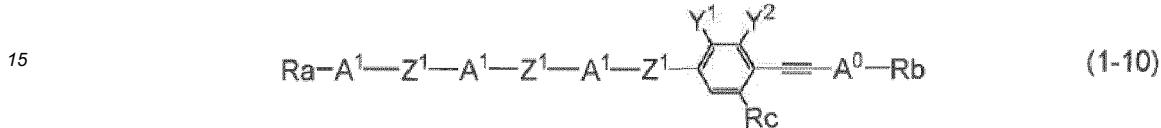
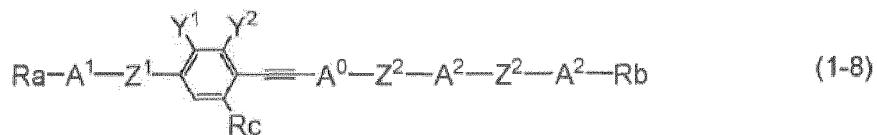
45



50



55



20 dans lequel, dans la formule (1-1) à la formule (1-10), Ra et Rb sont de façon indépendante l'hydrogène, le fluor, et au moins un $-\text{CH}_2-$ peut être remplacé par $-\text{O}-$, et au moins un $-\text{CH}_2\text{CH}_2-$ peut être remplacé par $-\text{CH}=\text{CH}-$ ou $-\text{C}=\text{C}-$, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor ou le chlore ; A^0 , A^1 et A^2 sont de façon indépendante le 1,4-cyclohexylène, le 1,4-phénylène, le décahydronaphtalène-2,6-diyl, le 1,2,3,4-térahydronaphtalène-2,6-diyl ou le naphtalène-2,6-diyl, et dans les anneaux, au moins un $-\text{CH}_2-$ peut être remplacé par $-\text{O}-$, et au moins un $-\text{CH}_2\text{CH}_2-$ peut être remplacé par $-\text{CH}=\text{CH}-$ et dans les anneaux, au moins un hydrogène peut être remplacé par le fluor, le chlore, $-\text{CF}_3$, $-\text{CHF}_2$ ou $-\text{CH}_2\text{F}$; Z^1 et Z^2 sont de façon indépendante une liaison unique ou un alkylène ayant de 1 à 4 carbones et dans l'alkylène, au moins un $-\text{CH}_2-$ peut être remplacé par $-\text{O}-$ ou $-\text{CO}-$, et au moins un $-\text{CH}_2\text{CH}_2-$ peut être remplacé par $-\text{CH}=\text{CH}-$, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor ou le chlore ; un de Y^1 et Y^2 est le fluor, et l'autre est l'hydrogène ; et Rc est un alkyle ayant de 1 à 4 carbones et dans l'alkyle, au moins un $-\text{CH}_2-$ peut être remplacé par $-\text{O}-$, et au moins un $-\text{CH}_2\text{CH}_2-$ peut être remplacé par $-\text{CH}=\text{CH}-$ ou $-\text{C}=\text{C}-$.

25

30

35

40

45

50

55

60

65

70

75

80

85

90

95

100

105

110

115

120

125

130

135

140

145

150

155

160

165

170

175

180

185

190

195

200

205

210

215

220

225

230

235

240

245

250

255

260

265

270

275

280

285

290

295

300

305

310

315

320

325

330

335

340

345

350

355

360

365

370

375

380

385

390

395

400

405

410

415

420

425

430

435

440

445

450

455

460

465

470

475

480

485

490

495

500

505

510

515

520

525

530

535

540

545

550

555

560

565

570

575

580

585

590

595

600

605

610

615

620

625

630

635

640

645

650

655

660

665

670

675

680

685

690

695

700

705

710

715

720

725

730

735

740

745

750

755

760

765

770

775

780

785

790

795

800

805

810

815

820

825

830

835

840

845

850

855

860

865

870

875

880

885

890

895

900

905

910

915

920

925

930

935

940

945

950

955

960

965

970

975

980

985

990

995

1000

1005

1010

1015

1020

1025

1030

1035

1040

1045

1050

1055

1060

1065

1070

1075

1080

1085

1090

1095

1100

1105

1110

1115

1120

1125

1130

1135

1140

1145

1150

1155

1160

1165

1170

1175

1180

1185

1190

1195

1200

1205

1210

1215

1220

1225

1230

1235

1240

1245

1250

1255

1260

1265

1270

1275

1280

1285

1290

1295

1300

1305

1310

1315

1320

1325

1330

1335

1340

1345

1350

1355

1360

1365

1370

1375

1380

1385

1390

1395

1400

1405

1410

1415

1420

1425

1430

1435

1440

1445

1450

1455

1460

1465

1470

1475

1480

1485

1490

1495

1500

1505

1510

1515

1520

1525

1530

1535

1540

1545

1550

1555

1560

1565

1570

1575

1580

1585

1590

1595

1600

1605

1610

1615

1620

1625

1630

1635

1640

1645

1650

1655

1660

1665

1670

1675

1680

1685

1690

1695

1700

1705

1710

1715

1720

1725

1730

1735

1740

1745

1750

1755

1760

1765

1770

1775

1780

1785

1790

1795

1800

1805

1810

1815

1820

1825

1830

1835

1840

1845

1850

1855

1860

1865

1870

1875

1880

1885

1890

1895

1900

1905

1910

1915

1920

1925

1930

1935

1940

1945

1950

1955

1960

1965

1970

1975

1980

1985

1990

1995

2000

2005

2010

2015

2020

2025

2030

2035

2040

2045

2050

2055

2060

2065

2070

2075

2080

2085

2090

2095

2100

2105

2110

2115

2120

2125

2130

2135

2140

2145

2150

2155

2160

2165

2170

2175

2180

2185

2190

2195

2200

2205

2210

2215

2220

2225

2230

2235

2240

2245

2250

2255

2260

2265

2270

2275

2280

2285

2290

2295

2300

2305

2310

2315

2320

2325

2330

2335

2340

2345

2350

2355

2360

2365

2370

2375

2380

2385

2390

2395

2400

2405

2410

2415

2420

2425

2430

2435

2440

2445

2450

2455

2460

2465

2470

2475

2480

2485

2490

2495

2500

2505

2510

2515

2520

2525

2530

2535

2540

2545

2550

2555

2560

2565

2570

2575

2580

2585

2590

2595

2600

2605

2610

2615

2620

2625

2630

2635

2640

2645

2650

2655

2660

2665

2670

2675

2680

2685

2690

2695

2700

2705

2710

2715

2720

2725

2730

2735

2740

2745

2750

2755

2760

2765

2770

2775

2780

2785

2790

2795

2800

2805

2810

2815

2820

2825

2830

2835

2840

2845

2850

2855

2860

2865

2870

2875

2880

2885

2890

2895

2900

2905

2910

2915

2920

2925

2930

2935

2940

2945

2950

2955

2960

2965

2970

2975

2980

2985

2990

2995

3000

3005

3010

3015

3020

3025

3030

3035

3040

3045

3050

3055

3060

3065

3070

3075

3080

3085

3090

3095

3100

3105

3110

3115

3120

3125

3130

3135

3140

3145

3150

3155

3160

3165

3170

3175

3180

3185

3190

3195

3200

3205

3210

3215

3220

3225

3230

3235

3240

3245

3250

3255

3260

3265

3270

3275

3280

3285

3290

3295

3300

3305

3310

3315

3320

3325

3330

3335

3340

3345

3350

3355

3360

3365

3370

3375

3380

3385

3390

3395

3400

3405

3410

3415

3420

3425

3430

3435

3440

3445

3450

3455

3460

3465

3470

3475

3480

3485

3490

3495

3500

3505

3510

3515

3520

3525

3530

3535

3540

3545

3550

3555

3560

3565

3570

3575

3580

3585

3590

3595

3600

3605

3610

3615

3620

3625

3630

3635

3640

3645

3650

3655

3660

3665

3670

3675

3680

3685

3690

3695

3700

3705

3710

3715

3720

3725

3730

3735

3740

3745

3750

3755

3760

3765

3770

3775

3780

3785

3790

3795

3800

3805

3810

3815

3820

3825

3830

3835

3840

3845

3850

3855

3860

3865

3870

3875

3880

3885

3890

3895

3900

3905

3910

3915

3920

3925

3930

3935

3940

3945

3950

3955

3960

3965

3970

3975

3980

3985

3990

3995

4000

4005

4010

4015

4020

4025

4030

4035

4040

4045

4050

4055

4060

4065

4070

4075

4080

4085

4090

4095

4100

4105

4110

4115

4120

4125

4130

4135

4140

4145

4150

4155

4160

4165

4170

4175

4180

4185

4190

4195

4200

4205

4210

4215

4220

4225

4230

4235

4240

4245

4250

4255

4260

4265

4270

4275

4280

4285

4290

4295

4300

4305

4310

4315

4320

4325

4330

4335

4340

4345

4350

4355

4360

4365

4370

4375

4380

4385

4390

4395

4400

4405

4410

4415

4420

4425

4430

4435

4440

4445

4450

4455

4460

4465

4470

4475

4480

4485

4490

4495

4500

4505

4510

4515

4520

4525

4530

4535

4540

4545

4550

4555

4560

4565

4570

4575

4580

4585

4590

4595

4600

4605

4610

4615

4620

4625

4630

4635

4640

4645

4650

4655

4660

4665

4670

4675

4680

4685

4690

4695

4700

4705

4710

4715

4720

4725

4730

4735

4740

4745

4750

4755

4760

4765

4770

4775

4780

4785

4790

4795

4800

4805

4810

4815

4820

4825

4830

4835

4840

4845

4850

4855

4860

4865

4870

4875

4880

4885

4890

4895

4900

4905

4910

4915

4920

4925

4930

4935

4940

4945

4950

4955

4960

4965

4970

4975

4980

4985

4990

4995

5000

5005

5010

5015

5020

5025

5030

5035

5040

5045

5050

5055

5060

5065

5070

5075

5080

5085

5090

5095

5100

5105

5110

5115

5120

5125

5130

5135

5140

5145

5150

5155

5160

5165

5170

5175

5180

5185

5190

5195

5200

5205

5210

5215

5220

5225

5230

5235

5240

5245

5250

5255

5260

5265

5270

5275

5280

5285

5290

5295

5300

5305

5310

5315

5320

5325

5330

5335

5340

5345

5350

5355

5360

5365

5370

5375

5380

5385

5390

5395

5400

5405

5410

5415

5420

5425

5430

5435

5440

5445

5450

5455

5460

5465

5470

5475

5480

5485

5490

5495

5500

5505

5510

5515

5520

5525

5530

5535

5540

5545

5550

5555

5560

5565

5570

5575

5580

5585

5590

5595

5600

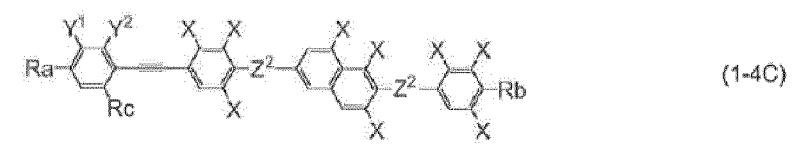
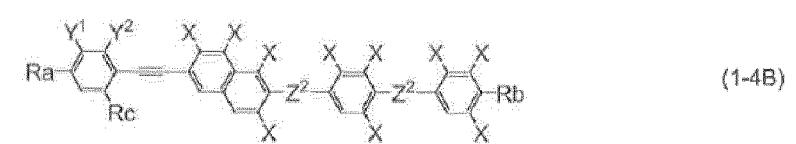
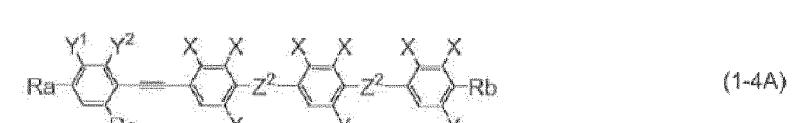
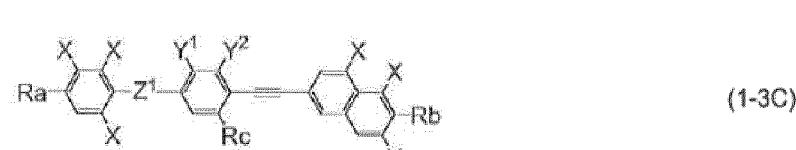
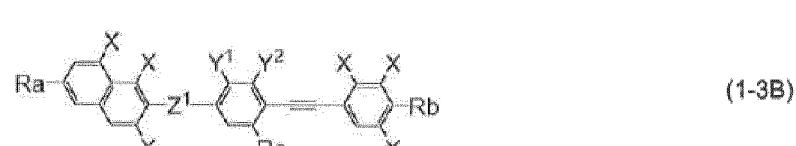
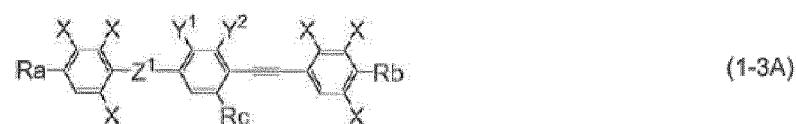
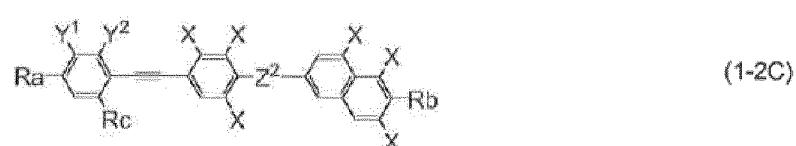
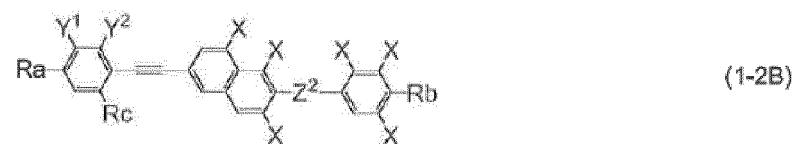
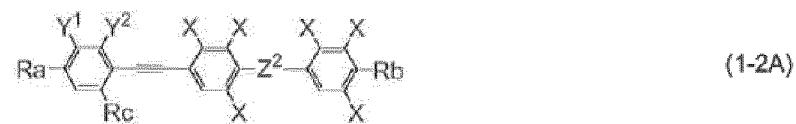
5605

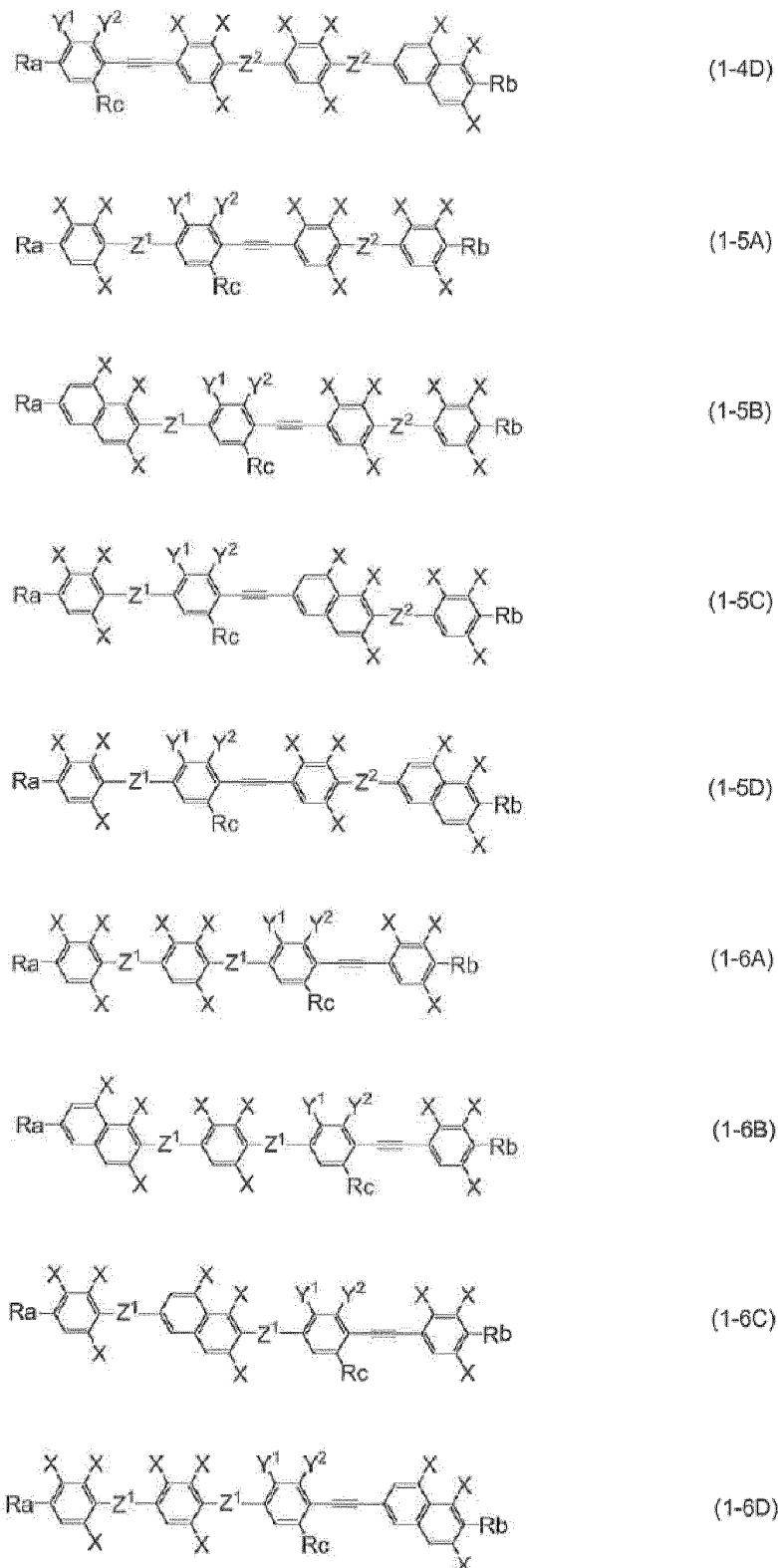
5610

5615

5620

5625





55 dans lequel, dans la formule (1-1A) à la formule (1-1B), dans la formule (1-2A) à la formule (1-2C), dans la formule (1-3A) à la formule (1-3C), dans la formule (1-4A) à la formule (1-4D), dans la formule (1-5A) à la formule (1-5D) et dans la formule (1-6A) à la formule (1-6D), Ra et Rb sont de façon indépendante l'hydrogène, le fluor, $-CF_3$, $-CHF_2$, $-CH_2F$, $-OCF_3$, $-OCHF_2$, $-OCF_2CHF_2$, $-OCF_2CHFCF_3$ ou un alkyle ayant de 1 à 10 carbones, et dans l'alkyle, au moins un $-CH_2-$ peut être remplacé par $-O-$ et au moins un $-CH_2CH_2-$ peut être remplacé par $-CH=CH-$; Z^1 et Z^2 sont de façon indépendante une liaison unique, $-CF_2O-$ ou $-OCF_2-$; un de Y^1 et Y^2 est le fluor, et l'autre est

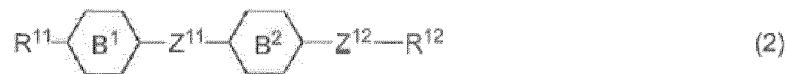
l'hydrogène ; Rc est le méthyle, l'éthyle ou le propyle ; et X est l'hydrogène ou le fluor.

7. Composé selon la revendication 6, dans lequel, dans la formule (1-1A), la formule (1-2A), la formule (1-3A), la formule (1-4A), la formule (1-5A), la formule (1-6A), la formule (1-1B), la formule (1-2B), la formule (1-2C), la formule (1-3B), la formule (1-3C), la formule (1-4B), la formule (1-4C), la formule (1-4D), la formule (1-5B), la formule (1-5C), la formule (1-5D), la formule (1-6B), la formule (1-6C), la formule (1-6D), Ra et Rb sont un alkyle ayant de 1 à 10 carbones ou un alkoxy ayant de 1 à 10 carbones ; Z¹ et Z² sont une liaison unique ; un de Y¹ et Y² est le fluor, et l'autre est l'hydrogène ; Rc est le méthyle, l'éthyle ou le propyle ; et X est l'hydrogène ou le fluor.

10 8. Composé selon la revendication 6, dans lequel, dans la formule (1-1A), la formule (1-2A), la formule (1-3A), la formule (1-4A), la formule (1-5A), la formule (1-6A), la formule (1-1B), la formule (1-2B), la formule (1-2C), la formule (1-3B), la formule (1-3C), la formule (1-4B), la formule (1-4C), la formule (1-4D), la formule (1-5B), la formule (1-5C), la formule (1-5D), la formule (1-6B), la formule (1-6C), la formule (1-6D), l'un de Ra et Rb est le fluor, -CF₃ ou -OCF₃ et l'autre est un alkyle ayant de 1 à 10 carbones ou un alkoxy ayant de 1 à 10 carbones ; Z¹ et Z² sont une liaison unique, -CF₂O- ou -OCF₂- ; Rc est le méthyle, l'éthyle ou le propyle ; l'un de Y¹ et Y² est le fluor, et l'autre est l'hydrogène ; et X est l'hydrogène ou le fluor.

9. Composition de cristaux liquides, contenant au moins un composé selon la revendication 1.

20 10. Composition de cristaux liquides selon la revendication 9, contenant en outre au moins un composé sélectionné dans le groupe de composés représentés par les formules (2) à (4) :

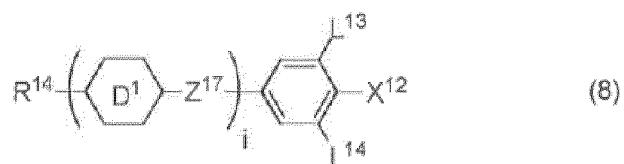
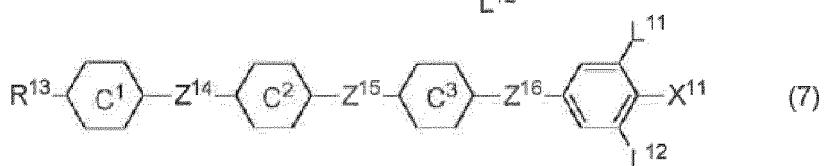
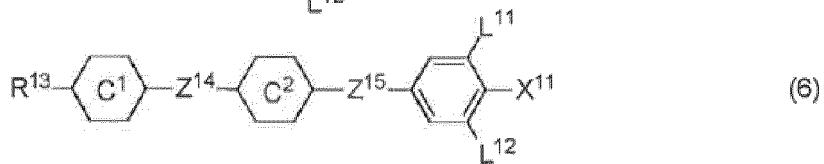
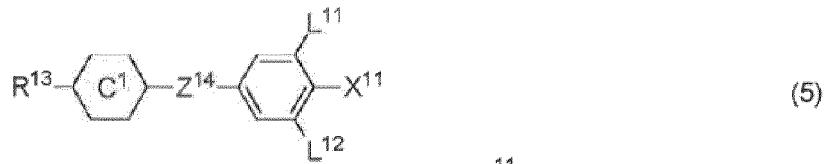


dans laquelle, dans les formules (2) à (4),

R¹¹ et R¹² sont de façon indépendante un alkyle ayant de 1 à 10 carbones ou un alkényle ayant de 2 à 10 carbones, et dans R¹¹ et R¹², au moins un -CH₂- peut être remplacé par -O-, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor ;

40 l'anneau B¹, l'anneau B², l'anneau B³, l'anneau B⁴ sont de façon indépendante le 1,4-cyclohexylène, le 1,4-phénylène, le 2-fluoro-1,4-phénylène, le 2,5-difluoro-1,4-phénylène ou la pyrimidine-2,5-diyl ; et Z¹¹, Z¹² et Z¹³ sont de façon indépendante une liaison unique, -COO-, -CH₂CH₂-, -CH=CH- ou -C=C-.

45 11. Composition de cristaux liquides selon la revendication 9, contenant en outre au moins un composé sélectionné dans le groupe de composés représentés par les formules (5) à (8) :



25 dans laquelle, dans les formules (5) à (7),

R¹³ est un alkyle ayant de 1 à 10 carbones ou un alkényle ayant de 2 à 10 carbones, et dans l'alkyle et l'alkényle, au moins un -CH₂- peut être remplacé par -O-, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor ;

X¹¹ est le fluor, le chlore, -OCF₃, -OCHF₂, -CF₃, -CHF₂, -CH₂F, -OCF₂CHF₂ ou -OCF₂CHFCF₃ ;

30 l'anneau C¹, l'anneau C² et l'anneau C³ sont de façon indépendante le 1,4-cyclohexylène, le 1,4-phénylène, le 1,4-phénylène dans lequel au moins un hydrogène est remplacé par le fluor, le tétrahydropyrane-2,5-diyl, le 1,3-dioxane-2,5-diyl ou la pyrimidine-2,5-diyl ;

Z¹⁴, Z¹⁵ et Z¹⁶ sont de façon indépendante une liaison unique, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CH=CH-, -C≡C- ou -(CH₂)₄- ;

35 L¹¹ et L¹² sont de façon indépendante l'hydrogène ou le fluor ; et dans laquelle, dans la formule (8),

R¹⁴ est un alkyle ayant de 1 à 10 carbones ou un alkényle ayant de 2 à 10 carbones et dans R¹⁴, au moins un -CH₂- peut être remplacé par -O-, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor ; X¹² est -C≡N ou -C=C-C≡N ;

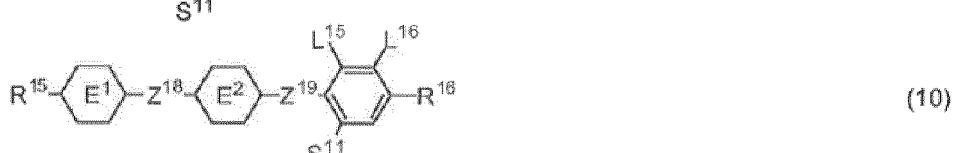
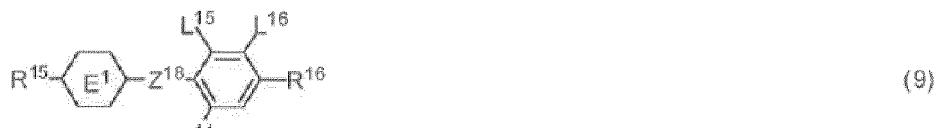
40 l'anneau D¹ est le 1,4-cyclohexylène, le 1,4-phénylène, le 1,4-phénylène dans lequel au moins un hydrogène est remplacé par le fluor, le tétrahydropyrane-2,5-diyl, le 1,3-dioxane-2,5-diyl ou la pyrimidine-2,5-diyl ;

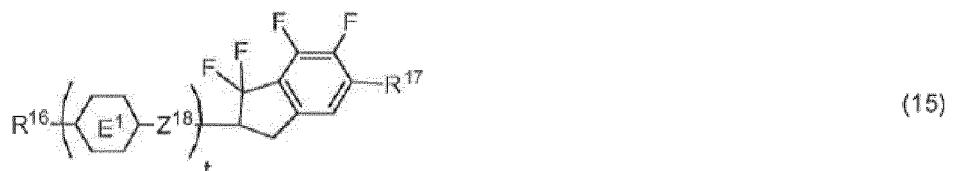
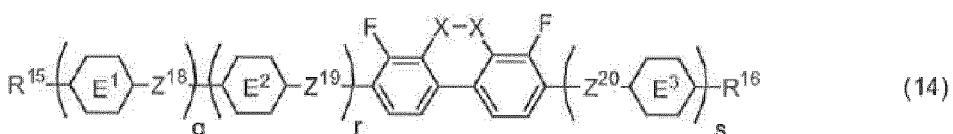
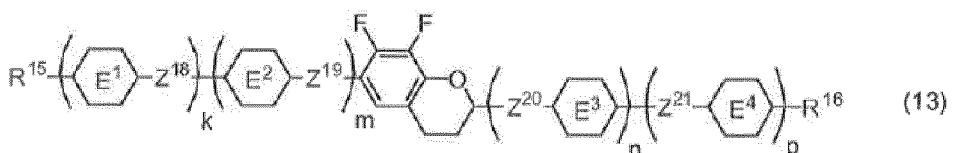
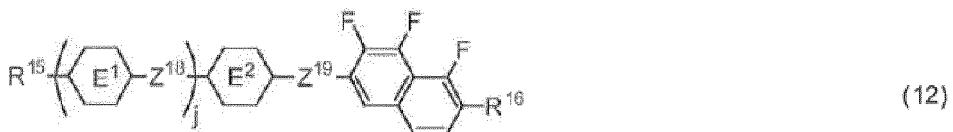
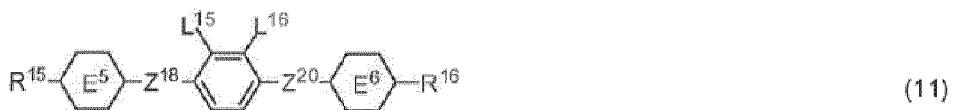
Z¹⁷ est une liaison unique, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -C≡C- ;

L¹³ et L¹⁴ sont de façon indépendante l'hydrogène ou le fluor ; et

i est 1, 2, 3 ou 4.

45 12. Composition de cristaux liquides selon la revendication 9, contenant en outre au moins un composé sélectionné dans le groupe de composés représentés par les formules (9) à (15) :





30 dans laquelle, dans les formules (9) à (15),

35 R¹⁵, R¹⁶ et R¹⁷ sont chacun de façon indépendante un alkyle ayant de 1 à 10 carbones ou un alkényle ayant de 2 à 10 carbones et dans R¹⁵, R¹⁶ et R¹⁷, au moins un -CH₂- peut être remplacé par -O-, et dans les groupes, au moins un hydrogène peut être remplacé par le fluor, dans lequel R¹⁷ peut être l'hydrogène ou le fluor ; l'anneau E¹, l'anneau E², l'anneau E³ et l'anneau E⁴ sont de façon indépendante le 1,4-cyclohexylène, le 1,4-cyclohexenylène, le 1,4-phénylène, le 1,4-phénylène dans lequel au moins un hydrogène est remplacé par le fluor, le tétrahydropyrane-2,5-diyl, ou le décahydronaphtalène-2,6-diyl ; l'anneau E⁵ et l'anneau E⁶ sont de façon indépendante le 1,4-cyclohexylène, le 1,4-cyclohexenylène, le 1,4-phénylène, le tétrahydropyrane-2,5-diyl ou le décahydronaphtalène-2,6-diyl ; Z¹⁸, Z¹⁹, Z²⁰ et Z²¹ sont de façon indépendante une liaison unique, -COO-, -OCO-, -CH₂O-, -OCH₂-, -CF₂O-, -OCF₂-, -CH₂CH₂-, -CF₂OCH₂CH₂- ou -OCF₂CH₂CH₂- ; L¹⁵ et L¹⁶ sont de façon indépendante le fluor ou le chlore ; S¹¹ est l'hydrogène ou le mthyle ; X est -CHF- ou -CF₂- ; et

40 j, k, m, n, p, a, r et s sont de façon indépendante 0 ou 1, une somme de k, m, n et p est 1 ou 2, une somme de q, r et s est 0, 1, 2 ou 3, et t est 1, 2 ou 3.

45

13. Dispositif d'affichage à cristaux liquides, incluant la composition de cristaux liquides selon la revendication 9.
- 50 14. Dispositif d'affichage à cristaux liquides selon la revendication 13, dans lequel la composition de cristaux liquides selon la revendication 9 est encapsulée.
- 55 15. Dispositif d'affichage à cristaux liquides selon la revendication 13, dans lequel la composition de cristaux liquids selon la revendication 9 est utilisée dans une lentille devant être utilisée dans la commutation entre 2D et 3D.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2006160727 A [0011]
- WO 2012126565 A [0011]
- WO 2012146340 A [0011]
- JP 2013241397 A [0072]
- JP 2009132927 A [0072]
- WO 2010047260 A [0072]

Non-patent literature cited in the description

- *Mol. Cryst. Liq. Cryst.*, 1985, vol. 131, 109 [0054]
- *Mol. Cryst. Liq. Cryst.*, 1985, vol. 131, 327 [0054]
- Organic Syntheses. John Wiley & Sons, Inc [0059]
- Organic Reactions. John Wiley & Sons, Inc, [0059]
- Comprehensive Organic Synthesis. Pergamon Press [0059]
- New Experimental Chemistry Course (Shin Jikken Kagaku Koza in Japanese). Maruzen Co., Ltd, [0059]
- TO M. KUROBOSHI et al. *Chem. Lett.*, 1992, 827 [0063]
- W. H. BUNNELLE et al. *J. Org. Chem.*, 1990, vol. 55, 768 [0063]
- PEER. KIRSCH et al. *Angew. Chem. Int. Ed.*, 2001, vol. 40, 1480 [0063]
- *J. Am. Chem. Soc.*, 2001, vol. 123, 5414 [0071]
- M. IMAI et al. *Molecular Crystals and Liquid Crystals*, 1995, vol. 259, 37 [0119]